

SIGNAL SECTION ADVANCE NOTICE

ASSOCIATION OF AMERICAN RAILROADS

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REPORTS

to be presented at the
Fifty-first Annual Meeting
CHICAGO, ILL.
September 12, 13 and 14, 1949

RULES OF ORDER

RESULT OF 1948 LETTER BALLOT

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ASSOCIATION OF AMERICAN RAILROADS
SIGNAL SECTION

COMMITTEE REPORTS

1948 Fiscal Year
(September 16, 1948—September 14, 1949)

Fifty-First Annual Meeting
Edgewater Beach Hotel
Chicago, Ill.

September 12, 13 and 14, 1949

The Committee of Direction suggests that papers of interest to the Signal Section be forwarded to the Secretary. They will be submitted to the proper committee for approval and printing in the literature.

ASSOCIATION OF AMERICAN RAILROADS

OPERATIONS AND MAINTENANCE DEPARTMENT

ENGINEERING DIVISION

SIGNAL SECTION

Office of the Secretary, 30 Vesey Street, New York 7, N. Y.

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D. W. Fuller, A. T. & S. F. Ry., Chairman.
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Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on the economics of railway signaling.

The Committee submits for consideration, reports on the following subjects**:

1. Revision of A.A.R. Signal Section Form 24—Economic Statement, Manual Part 29.

3. Economics of centralized traffic control replacing manual block and train orders between Tyrone and Lock Haven, Pa., Pennsylvania R.R.

Economics of centralized traffic control replacing manual block between Laredo and Polo, Mo., Chicago, Milwaukee, St. Paul & Pacific R.R.

Economics of automatic, auto-manual and manual controlled highway crossing protection devices.

Economics of centralized traffic control which postponed the construction of a second main track on the Missouri Pacific R.R., between Edgewater Junction and Atchison, Kans.

Economics of centralized traffic control in lieu of second main track on sections of the Chicago, Milwaukee, St. Paul & Pacific R.R. between Glencoe, Minn. and Milbank, S. Dak.

Economics of remote control train order signals in two-track automatic block signal territory between Buffalo and Johnson City, N. Y., on the Delaware, Lackawanna & Western R.R.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

Formula for estimating train miles saved due to increased tonnage with centralized traffic control.

Advantages of elimination of Standard Code Rule 93 in centralized traffic control territory.

Effect of various classes of track on taxation.

Train hour value.

Economics of communication between front and rear end and between engines, trains and fixed points.

Summary of economic results, January 1, 1948.

Railroad-highway grade crossings equipped with gates, watchmen and signals in the United States, December 31, 1946.

Types of protection at railroad highway grade crossings in the United States, December 31, 1945 and 1946.

Spring switches in service in the United States as of January 1, 1948.

Aggregate length of lines and parts of lines on which the automatic block signal system, automatic train stop, automatic train control, automatic cab signal devices and centralized traffic control were in use—January 1, 1908-1948.

Annual maintenance, operation, and investment charges for railway signals and interlockings on Class I Railroads, U.S.A., 1908-1947.

Economics of precast materials for signal work.

Economics of dragging equipment detectors.

Freight train time saved where trains are operated by signal indication.

Operating advantages of manually operated interlocking on Chicago & Eastern Illinois R.R. at crossing with Wabash R.R. and Peoria & Eastern Ry. (New York Central R.R.) at Danville, Ill.

Advantages of rock slide detector fences.

Economics of use of yard track indicators.

Economics of "Off Track" equipment.

ECONOMICS OF CENTRALIZED TRAFFIC CONTROL
REPLACING MANUAL BLOCK AND TRAIN ORDERS
BETWEEN TYRONE AND LOCK HAVEN, PA.,
PENNSYLVANIA R.R.*

The Pennsylvania R.R. installed centralized traffic control in 1946, on 52.7 miles of road and 57.7 miles of track on its Bald Eagle Branch between Tyrone and Lock Haven, Pa., where formerly trains were governed by manual block and train orders. Tyrone is 116.6 miles west of Harrisburg on the route between New York and Pittsburgh, and Lock Haven is 118 miles northwest of Harrisburg on the route between New York and Buffalo, via Harrisburg.

From Tyrone, elevation 806 feet, the line ascends eastward at 0.6 to 0.8 per cent grade for about 8 miles to Dix, at an elevation of 1,110 feet, from which the Railroad descends down the valley of the Bald Eagle Creek to Lock Haven at an elevation of 555 feet. Curves are fairly numerous but none is sharp enough to limit freight trains below 45 m.p.h., the authorized freight train speed for this territory. Rail is 130 pound and siding turnouts are No. 15. The four controlled sidings have capacities for 234, 137, 144, and 408 cars. Some years ago, a second main track on a more favorable alignment was constructed between Wood and Sands, 5 miles. Two sidings were eliminated for regular meets and passes with centralized traffic control.

Where the distance between sidings ranges from 7.5 to 10 miles, there are two double locations of intermediate signals. Where the distance is about 5 miles, there is one location of intermediates. Where the distance is 3 miles, there are no intermediate signals.

The centralized traffic control machine is located at Milesburg, 31 miles east of Tyrone at a junction with the Bellefonte Branch. Interesting features of this centralized traffic control project include signals to facilitate train movements into and out of the sidings, intermediate signals on the sidings, either-direction signaling on the 5-mile two-track section, and six dragging equipment detectors.

About 75 per cent of the eastward traffic consists of loaded coal cars, which return westward empty. About six or seven coal trains are operated eastward daily. Helper service is provided from Tyrone to Dix. Five preference merchandise freight trains are operated each way daily, besides one passenger and one local train. The total trains daily range from 25 to 30.

* *Railway Signaling*, January 1947, pp. 31-41.

Economic Statement

1. Cost of Installation:		
(a) Capital Investment.....	\$614,761	
(b) Operating Expenses.....	274,677	
(c) Total.....		\$889,438
2. Gross Saving per Annum.....		\$166,907
3. Increased Annual Operating Expenses.....		14,911
4. Net Reduction in Annual Operating Expenses.....		\$151,996
5. Deduction for Interest Charges @ 6% (of 1-a).....		36,886
6. Net Saving per Annum.....		\$115,110
7. Annual Return over 6% Interest:		
(a) On Capital Investment ($6 \div 1-a$).....		18.7%
(b) On Total Cost ($6 \div 1-c$).....		12.9%

Summary of Advantages of Centralized
Traffic Control

1. Train stops and slow-downs have been reduced.
2. Average road time per freight train has decreased 36 minutes eastward and 59 minutes westward.
3. Average speed of freight train has increased 2.8 m.p.h. eastward and 4 m.p.h. westward.
4. Reduced annual operating expenses \$115,110.
5. The use of track circuits on sidings with intermediate automatic block signals has expedited train movements.
6. Increased the capacity of the line.

Action Recommended

Acceptance as information.

ECONOMICS OF CENTRALIZED TRAFFIC CONTROL
REPLACING MANUAL BLOCK BETWEEN LAREDO
AND POLO, MO., CHICAGO, MILWAUKEE,
ST. PAUL & PACIFIC R.R.*

The Chicago, Milwaukee, St. Paul & Pacific R.R. installed centralized traffic control in 1944, on 51 miles of single-track main line between Laredo and Polo, Mo., where formerly trains were governed by manual block and train orders. This territory is on the main route from Kansas City to Chicago and Milwaukee. At Polo, the west end of the territory, the single track joins the two main tracks jointly operated with the Chicago, Rock Island & Pacific Ry., previously equipped with centralized traffic control for signal indication operation to Kansas City, Mo.

While the track alignment is 83 per cent tangent, there are 31 curves between 2 and 5 degrees, one $1\frac{1}{2}$ degree, and the balance are 1 degree or less. The grade is rolling with an eastward ruling grade of 0.75 per cent, 2 miles long, and a westward ruling grade of 0.75 per cent, 5 miles long. Rail is either 112 or 110 pound and siding turnouts are No. 11. With centralized traffic control, five switches and 6,308 feet of track were removed, two sidings were extended a total of 2,500 feet, and two of the seven sidings were eliminated. Two of the five sidings are 111-car and three sidings are 87-car capacity.

The centralized traffic control machine is located in the dispatcher's office at Ottumwa, Ia., one subdivision or 104 miles east of Laredo. The centralized traffic control codes are superimposed on an existing dispatcher's circuit by means of carrier apparatus. This circuit also includes a simplex telegraph circuit and the telephone train dispatching circuit. The track circuits are of the direct current non-code type through the stations and double-ended code type between stations. No line circuits are required for the intermediate signal controls between stations except in connection with electric switch locks, highway grade crossing protection and other special conditions.

Station-to-station blocks are used in two cases where the siding switches are 5 to 6 miles apart. Where the siding switches are over 6 miles apart, additional intermediate block signals are provided.

There was an average of 2 through passenger, 2 local passenger, and 10 freight trains daily, or a total of 14 trains. The daily traffic varied from 12 to 18 trains. Maximum speed was 70 m.p.h. for passenger and 50 m.p.h. for freight trains. Diesel freight locomotives were in use on four time freights prior to the centralized traffic control installation.

A "Before and After" centralized traffic control study was made based on 7 days in October 1944 and 1945. Train movements daily averaged 13.9 for the 7 days in 1944 compared to 14 daily for the same 7 days in 1945. There were 8.7 through freight trains daily in 1944 compared to 7.6 in 1945, but the tonnage per train was 32 per cent greater in 1945.

* *Railway Signaling*, April 1945, pp. 225-234.

The annual gross savings were estimated as follows:

648 Through freight train hours.....	\$11,871
2,190 Car days.....	2,890
17,498 Freight train miles.....	26,780
Train stops saved.....	2,628
Eliminating train orders.....	5,885
3,808 Feet track saved.....	415
5 Switches saved.....	1,000
12 Switch lamps saved.....	180
Total.....	\$51,649

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$173,644
(b) Operating Expenses.....	13,645
(c) Total.....	\$187,289
2. Gross Saving per Annum.....	\$ 51,649
3. Increased Annual Operating Expenses.....	9,126
4. Net Reduction in Annual Operating Expenses.....	\$ 42,523
5. Deduction for Interest Charges @ 3% (of 1-a).....	5,209
6. Net Saving per Annum.....	\$ 37,314
7. Annual Return over 3% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	21.5%
(b) On Total Cost ($6 \div 1-c$).....	19.9%

Summary of Advantages of Centralized Traffic Control on Light Traffic 51-Mile Line of Chicago, Milwaukee, St. Paul & Pacific R.R. Between Laredo and Polo, Mo.

1. Provided an improved block signal system with signal indication operation and increased safety of train operation in lieu of former manual block operation with train orders.
2. Reduced road time of through freight trains.
3. Saved 648 through freight train hours and locomotive hours per year.
4. The tonnage of through freight trains was increased 32 per cent in 1945 compared to 1944.
5. Saved 17,498 freight train miles per year.
6. Saved 2,190 car days per year.

Sept. 1949]

Com. I—Economics of Ry. Signaling

7. Saved maintenance on 3,808 feet of track, 5 main line switches, and 12 switch lamps.
8. Eliminated two sidings.
9. Reduced the cost of directing train movements by \$5,885 per year.
10. Reduced annual operating expenses \$37,314.
11. Increased the capacity of the line for future traffic.

Action Recommended

Acceptance as information.

ECONOMICS OF AUTOMATIC, AUTO-MANUAL AND
MANUAL CONTROLLED HIGHWAY CROSSING
PROTECTION DEVICES**Des Moines Union Ry.*

In 1949, an installation of flashing light signals was carried out by the Des Moines Union Ry. at a group of five street crossings on its two track main line at Des Moines, Ia. The crossings are in the vicinity of the Union Depot and trains of the Des Moines Union, Wabash, Chicago Great Western, Burlington and Milwaukee Roads operate through that territory. The new protection is manually controlled from a centrally located elevated tower with 24-hour service. Signals are of the cantilever bracket type. The control panel includes track section indication for the two outer crossings on each side. The crossings formerly had only part-time protection afforded by eight watchmen. Thus safety has been increased and economies effected.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$ 27,329
(b) Operating Expenses.....	624
(c) Total.....	<u>\$ 27,953</u>
2. Gross Saving per Annum.....	\$ 23,181
3. Increased Annual Operating Expenses.....	<u>11,401</u>
4. Net Reduction in Annual Operating Expenses.....	\$ 11,780
5. Deduction for Interest Charges @ 6% (of 1-a).....	<u>1,640</u>
6. Net Saving per Annum.....	<u><u>\$ 10,140</u></u>
7. Annual Return over 6% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	37.1%
(b) On Total Cost ($6 \div 1-c$).....	36.3%

* Previous report on this subject appears in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 31-A and 331-A.

*Chicago, Milwaukee, St. Paul & Pacific R.R.
and Chicago & North Western Ry.*

In 1948, installations of flashing light signals with short-arm gates were made at the crossings of Dutch Creek Road over the two main tracks of the Chicago, Milwaukee, St. Paul & Pacific R.R. and the single-track line of the Chicago & North Western Ry. at Bangor, Wis. The crossings were formerly protected by manually controlled gates during 16 hours of the day, supplemented by automatic wig-wag signals on each Company's tracks. The new protection consists of modern electric gates and A.A.R. flashing light signals arranged for automatic operation. As the two roads are some 325 feet apart, separate protection is provided for each individual crossing. The economic statement is a consolidated report for both roads.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$ 13,157
(b) Operating Expenses.....	891
(c) Total.....	\$ 14,048
2. Gross Saving per Annum.....	\$ 5,830
3. Increased Annual Operating Expenses.....	200
4. Net Reduction in Annual Operating Expenses.....	\$ 5,630
5. Deduction for Interest Charges @ 6% (of 1-a).....	789
6. Net Saving per Annum.....	\$ 4,841
7. Annual Return over 6% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	36.8%
(b) On Total Cost ($6 \div 1-c$).....	34.5%

Grand Trunk Western R.R.

Under the Grand Trunk Western R.R. Company's recent modernization program, flashing light signals with short-arm gates were installed at nine street crossings in Detroit, replacing manually operated mechanical gates, and flashing light signals without gates were provided at one crossing previously protected by flagmen. An inter-communicating loud speaker system was installed between central towers to give towermen advance information on approaching trains. Through a rearrangement of the control points, 18 crossing watchman positions were eliminated and, in addition to the nine sets of mechanical crossing gates, two watchmen's cabins and three elevated gate towers were retired.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$ 37,516
(b) Operating Expenses.....	604
(c) Accrued Depreciation.....	5,811
(d) Total.....	<u>\$ 43,931</u>
2. Gross Saving per Annum.....	\$ 46,370
3. Increased Annual Operating Expenses.....	—
4. Net Reduction in Annual Operating Expenses.....	\$ 46,370
5. Deduction for Interest Charges @ 6% (of 1-a).....	2,250
6. Net Saving per Annum.....	<u>\$ 44,120</u>
7. Annual Return over 6% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	117.6%
(b) On Total Cost ($6 \div 1-d$).....	100.4%

New York, New Haven & Hartford R.R.

In 1946 and 1947, the New York, New Haven & Hartford R.R. installed automatically controlled flashing light signals with short-arm gates at five crossings in Taunton, Mass. Previously these five crossings were protected manually 24 hours per day, 7 days per week, four crossings having manually operated gates and one crossing protected by watchman.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$ 37,407
(b) Operating Expenses.....	6,914
(c) Total.....	<u>\$ 44,321</u>
2. Gross Saving per Annum.....	\$ 44,158
3. Increased Annual Operating Expenses.....	<u>3,395</u>
4. Net Reduction in Annual Operating Expenses.....	\$ 40,763
5. Deduction for Interest Charges @ 2% (of 1-a).....	<u>748</u>
6. Net Saving per Annum.....	<u>\$ 40,015</u>
7. Annual Return over 2% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	107.0%
(b) On Total Cost ($6 \div 1-c$).....	90.3%

Pennsylvania R.R.

In 1948, the Pennsylvania R.R.* installed flashing light signals, bells, and short-arm gates at nine street crossings on its two main track line in Steubenville, Ohio. This protection is in service 24 hours daily and provides uniform maximum protection at all crossings on the Pennsylvania R.R. tracks throughout the City. Previously, these nine crossings were equipped with compressed air gates.

The project includes automatic control by track circuits, supplemented by manual control for special train movements. The bells operate when the gate is being lowered and raised, but not while the gate is down. In addition to the track circuits for approach control, a separate short track circuit was installed on each track across each street. This applies not only on main tracks but also on spur and house tracks. Each such track circuit extends not only across the street, but also about 70 feet in each direction beyond the street line.

The manual control is operated from two new brick watchmen's towers. The control machines in the two towers are identical so that the man in either tower can control the entire area in case the man in the other tower is absent. When a train runs through Steubenville at normal speed, without stopping, the crossing gates are controlled automatically by the track circuits without action by the crossing watchmen. The installation includes "No Right Turn" and "No Left Turn" signs.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$173,650
(b) Operating Expenses.....	27,402
(c) Total.....	<u>\$201,052</u>
2. Gross Saving per Annum.....	\$ 53,761
3. Increased Annual Operating Expenses.....	5,400
4. Net Reduction in Annual Operating Expenses.....	\$ 48,361
5. Deduction for Interest Charges @ 6% (of 1-a).....	10,419
6. Net Saving per Annum.....	<u>\$ 37,942</u>
7. Annual Return over 6% Interest:	
(a) On Capital Investment (6 ÷ 1-a).....	21.8%
(b) On Total Cost (6 ÷ 1-c).....	18.9%

Action Recommended

Acceptance as information.

* *Railway Signaling*, November 1948, pp. 675-679.

ECONOMICS OF CENTRALIZED TRAFFIC CONTROL WHICH
POSTPONED THE CONSTRUCTION OF A SECOND MAIN
TRACK ON THE MISSOURI PACIFIC R.R., BETWEEN
EDGEWATER JUNCTION AND ATCHISON, KANS.*

The Missouri Pacific R.R. installed centralized traffic control on 43 miles between Edgewater Junction (Kansas City), and Atchison, Kans. in 1929. Train operation previous to the centralized traffic control was by time-table, train orders and manual block. The traffic varied from 40 to 50 trains a day with occasional peaks of 60 trains.

This single-track line runs along the Missouri River and in many places is hemmed in by the river on one side and by high bluffs on the other. Therefore, because of the extensive work that would have been required to provide a second track on the same grade and alignment, it was concluded that a new right-of-way would have been necessary to provide two main tracks.

It is now believed that if centralized traffic control had not been available at the time, it would have been necessary to provide two main tracks in order to handle the traffic which has since been handled.

No estimate of the cost of providing an additional main track was made, but the installation of centralized traffic control on the single main track has provided sufficient capacity to make unnecessary the construction of additional main trackage.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1931 Proceedings, Vol. XXIX, p. 45.

ECONOMICS OF CENTRALIZED TRAFFIC CONTROL IN
LIEU OF SECOND MAIN TRACK ON SECTIONS OF
THE CHICAGO, MILWAUKEE, ST. PAUL &
PACIFIC R.R. BETWEEN GLENCOE, MINN.
AND MILBANK, S. DAK.*

The Chicago, Milwaukee, St. Paul & Pacific R.R. installed centralized traffic control on 137 road miles between Glencoe, Minn. and Milbank, S. Dak. in 1945 and 1946. This project included the retirement of 34.94 miles of second track, of which 7.13 miles were converted to side track.

The former operation consisted of 10 miles of automatic block signaling with the remaining territory under operation by train orders and manual block. Traffic varied from 15 to 24 trains a day. Sidings were 7,000 feet in length with No. 11 and No. 16 turnouts. Two interlockings were converted to semi-automatic operation.

A special feature of this installation was the retirement of a substantial investment in grading for additional second main track where track had never been laid. The retirements, consisting principally of 28 miles of track and grading amounted to a gross retirement credit to capital account of \$1,085,389, or a net credit of \$464,886 for the entire project. No economic statement for the entire project which would reflect these retirements has been made.

The installation of centralized traffic control on the single track has provided sufficient capacity to permit the removal of the second main track.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, p. 26-A.

ECONOMICS OF REMOTE CONTROL TRAIN ORDER SIGNALS
IN TWO-TRACK AUTOMATIC BLOCK SIGNAL TERRITORY
BETWEEN BUFFALO AND JOHNSON CITY, N. Y., ON
THE DELAWARE, LACKAWANNA & WESTERN R.R.

This report covers a recent installation which involves the use of telephone train order signals remotely controlled by means of centralized traffic control type equipment to effect signal indication operation, with respect to following movements, on portions of a two-track main line. Control of these signals, and other signaling and interlocking facilities at several locations is accomplished by the use of coded centralized traffic control circuits which are superimposed on an existing dispatcher's telephone line. The various wayside facilities are operated from a control machine located in the train dispatcher's office at the west end of the territory.

The installation is on the Buffalo Division of the Delaware, Lackawanna & Western R.R. between Buffalo and Johnson City, N. Y., a 200-mile two-track division comprising one freight operating district of 146 miles between Buffalo and Elmira, N. Y. and a 54-mile portion of the 125-mile freight operating district between Elmira, N. Y. and Scranton, Pa. (See Fig. 1.)

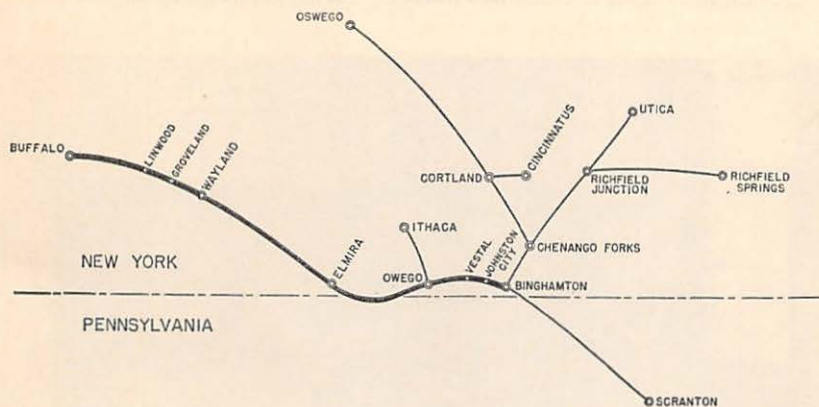


Fig. 1.

Density of traffic, measured in number of trains operated, is moderate for a two-track main line, there being 8 passenger trains and from 20 to 30 freight trains operated per day. Average through train length east of Elmira is about 85 cars, and west of Elmira about 105 cars. Train tonnages vary considerably as to the same length of train because of differences in commodities carried, maximum tonnage being about 7,000 tons, and maximum number of cars, 120.

Eastward through freight trains are helped from Groveland to Wayland, N. Y., a distance of approximately 14 miles, about midpoint in the Buffalo-Elmira freight operating district. This helper district brings about some additional movement density because of returning light helpers, and also serves to cause a natural spacing between eastward trains because all eastward helper

service is normally performed by one Diesel helper stationed at Groveland. Helper service is also provided on a few trains west out of Groveland to Linwood, N. Y., approximately 15 miles. The need for westward helper service is less because of the generally lighter tonnage which makes it possible for many trains to be handled singly.

The line between East Buffalo and Johnson City is equipped with automatic block signals, train orders, and continuous automatic cab signals, the wayside signal system east of Elmira having been completely modernized within the past few years, and color light signals installed to replace semaphore signals. Modernization of the signal system west of Elmira is in progress, approximately 25 miles of road having been modernized during 1948, and about 35 miles scheduled for 1949.

The installation consists of a centralized traffic control type multiple-line code circuit, superimposed on an existing dispatcher's line over which telephone type train order signals and other remotely controlled signal facilities are controlled from a machine in the train dispatcher's office at Buffalo. The line is equipped with the usual selectors and other equipment for telephone train dispatching. The unique feature of the installation is primarily the establishment of a 200-mile signal control line for operation of a variety of remote controls and for reception of "OS" and other indications over a complete main line dispatcher's territory. It is of interest from an economic standpoint because it illustrates the use of centralized traffic control developments for the central-

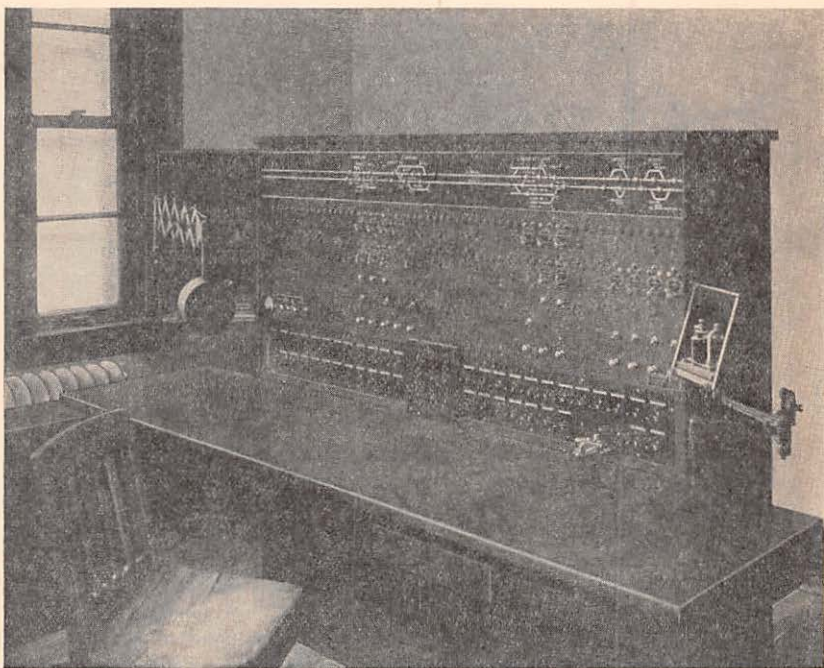


Fig. 2.

ized control of a variety of signal functions, which may or may not provide continuous signal indication operation and may involve the control of a number of locations not necessarily governing related train movements. Figure 2 shows the control machine in the dispatcher's office at Buffalo.

When the installation was first placed in service in the latter part of 1944, the only wayside facilities controlled were five telephone train order signals at three stations. The installation has since been expanded so that the remotely controlled signal facilities controlled from the central control machine are as follows:

Station	Miles from control point	Facilities controlled
1. Groveland, N. Y.	69.3	(a) Entrance switch for eastward siding. (b) Electric lock on hand-operated main line crossover.
2. Wayland, N. Y.	83.7	(a) Entrance switch for eastward siding. (b) Electric lock on hand-operated main line crossover. (c) Telephone train order signal governing westward movements.
3. Elmira, N. Y.	146.7	(a) Entrance and exit switches at east end of yard.
4. Owego, N. Y.	182.7	(a) Telephone train order signal governing eastward movements. (b) Telephone train order signal governing westward movements.
5. Vestal, N. Y.	195.3	(a) Telephone train order signal governing eastward movements. (b) Telephone train order signal governing westward movements.

It is anticipated that additional wayside functions will be incorporated in the centralized remote control installation as additional segments of the signaling between Buffalo and Elmira are modernized.

Economic and Operating Advantages

The economic and operating advantages from this installation result not only from the controlled functions themselves, but also from the fact that a number of functions can be controlled by centralized traffic control type circuits from a central point rather than from a larger number of local control

points. The Buffalo Division installation, as initially installed, involved the control of signals at the entering ends of five sidings located at three stations. The installation, as in service at this time, includes remote-controlled interlocking functions at three stations. Under usual remote control practices, the functions now being controlled from the central machine would have been controlled from five local stations.

While it would have been entirely feasible from a signaling standpoint to control the various functions remotely from open stations on the line, a comparative cost analysis, which balanced line wire costs against code apparatus costs, using the existing dispatcher's line as a vehicle for the code circuit, indicated that the differential in installation costs would tend to favor the centralized traffic control type circuit installation as the number of field locations increased.

The economic advantages of this remote control installation result both from the operation of the outlying signal facilities, which favorably affect train performance locally, and from the centralized feature of the control which makes it possible to install these facilities where it is not practical to install them with ordinary direct wire remote control circuits because of distance from open offices.



Fig. 3.

The installation is also of interest because it embraces the use of a type of signal which, although it has had only limited application, has demonstrated its utility as a means of establishing passing points on a two-track railroad. This is the telephone train order signal, which functions to permit movement of inferior class trains, irrespective of following superior schedules, until an indication to take siding is displayed.

The telephone train order signal is not a new development, having been first used on the Erie R.R. in 1910. A complete description of the use of this signal appears in a paper by Mr. M. A. Baird, then Signal Engineer of the Erie R.R., in A.A.R. Signal Section 1925 Proceedings, Vol. XXII, p. 757. Prior to the installation here described, the Delaware, Lackawanna & Western R.R. had three such installations on the Buffalo Division. Two of these were at Owego and were incorporated into the present installation. (See Fig. 3.) The other, governing the entrance to eastward siding at Wayland, has been superseded by the remote control of entrance switch to this siding, now a part of the present installation.

Rule 509-J of the Operating Rules of the Delaware, Lackawanna & Western R.R., quoted below, describes the signal and defines its aspects and indications:

“Rule 509-J

“Position Light Telephone Train Order Signal

“This type signal is used in automatic block signal territory to avoid train stops and to enable train dispatchers to direct train movements by signal indications.

“It is a position light unit attached to signal pole, below the automatic signal lights or blades, and displaying white lights in various positions.

“Location of such position light Telephone Train Order Signals will be designated by timetable or special instructions.

“These signals do not authorize or permit the disregard of any other fixed signals, neither do their indications modify the meaning of automatic signal indications except as indicated below:

Indications

“(a) Lights Vertical
(At 90° above
Horizontal)

Proceed, regardless of following superior trains, except that automatic signal indication must be observed. If there is any known cause that will prevent making usual running time, information should be given and instructions received by telephone. After a train accepts the proceed indication and for any cause is unable to make the usual running time, train must be protected as prescribed by Rule 99.

"(b) Lights Diagonal
(At 45° above
Horizontal)

Freight Trains: Taking siding report by telephone when clear of the main track. Automatic Signal showing "Stop and Proceed" indication may be passed without stopping and train proceed at restricted speed to entrance switch of siding.

Passenger Trains: Stop and report by telephone before taking siding.

Note: Where siding cannot be used, or there is no siding, making it necessary to back train over to the opposing track, train may proceed at restricted speed until rear of train clears crossover.

After permission is received from the train dispatcher, signalman or operator in charge, train may back over to the opposing track, protecting movement as prescribed by Rule 99.

"(c) Lights Horizontal Stop on main track and report by telephone for instructions. (It is forbidden to use a crossover at any point where a train order signal is located without permission.)

"*Note:*

The absence of one of the three lights does not restrict the observance of the signal if the indication is clearly apparent from the remaining lights."

Operating Advantages of Installation

Improved operating conditions arising from the installation result from:

(a) Its function as an OS system, which keeps dispatcher accurately informed as to the progress of trains approaching the telephone train order signals and other remote control locations.

(b) Ability of dispatcher to advance a train beyond a point where it would normally take siding for a following superior train when the latter is late.

(c) Ability of the dispatcher to reverse the order of trains when the leading train is not making a good run, and the following train can be run around it advantageously.

(d) Ability to accept trains for movement from the connecting division at Johnson City, even though train is on close time ahead of following superior train and to run the first train to Vestal or Owego.

(e) Provision of superior control over passing movements over that provided indirectly when instructions are given through operators.

(f) Provision of a means of stopping trains for instructions in event of emergency or dangerous condition reported by employees observing passage.

(g) The advantages to train movement resulting from elimination of train stops and delay at the remote control installations where control of switches not previously power operated are involved.

Operating Savings

A. Resulting from initial installation involving remote control of telephone type train order signals.

1. It is estimated that an average of at least one train a day would be advanced one or more stations because of the functioning of the three new telephone train order signals installed in connection with this project, and that the average expedited time would be 20 minutes per train so advanced. While the same saving could be expected from each of the other three such signals which were in service prior to the completion of this project, the savings cannot be ascribed to this improvement. The annual freight train time saving would be as follows:

$$3 \text{ trains} \times 20 \text{ minutes} \times 365 = 365 \text{ freight train hours.}$$

2. In some cases, the advance of a train would result in reduction in the number of train stops because the train would be able to proceed to the terminal having made one less movement through a siding. Assuming that one such move would be made per day, and that three stops would be saved as a result, the annual number of freight train stops would be as follows:

$$3 \text{ stops} \times 365 = 1,095 \text{ stops.}$$

3. Remote control of the telephone train order signals at Vestal and Owego from Buffalo has made it possible to operate these two stations as two-trick rather than three-trick offices.

B. Resulting from remote control additions to the installation.

1. The two remote controls at Groveland and Wayland, respectively, provide a facility at the base and summit of the helper grade which provide for greater flexibility and make it possible to advance trains up the grade on shorter time ahead of passenger trains. It is estimated that an average saving of two freight train hours per day and six freight train stops result from these installations.

$$2 \times 365 = 730 \text{ freight train hours per year.}$$

$$6 \times 365 = 2,190 \text{ freight train stops per year.}$$

2. Remote control of the switches at the east end of Elmira released switch tenders who formerly operated the switches in question from a table-lever layout so that the switch tenders now are used solely for yard work.

C. Summary of annual operating savings.

1,095 Freight train hours @ \$28.03 (1946)	=	\$30,692
3,285 Freight train stops @ 2.00	=	6,570
Saving at train order offices	=	20,000

Gross operating saving..... \$57,262

D. Deductions from operating saving.

The installation has not required addition to maintenance force and, therefore, will affect maintenance and operating expense of signaling on the Division only to the extent that requirements of the new signaling require maintenance material and depreciation. It is estimated that the annual cost in these categories would be as follows:

Additional maintenance and operation.....	\$3,000
Depreciation @ 3%.....	2,354
Total deductions from operating saving	\$5,354

Cost of Installation

The installation of remote control telephone train order signals was made as a part of a project which involved extension of the two sidings at Vestal and the westward siding at Wayland and the relocation of water facilities at Wayland. The portion of the project cost attributable to the installation and remote control of three new telephone train order signals, remote control of the two existing signals at Owego, and rehabilitation of selector system and dispatcher's line, was as follows:

Capital investment.....	\$18,475
Operating expenses.....	5,000
Total cost.....	\$23,475

Additions to the installation were made as a part of projects involving modernization of the signal system in the areas where the remote controls were installed. The portion of the total project costs involving the remote controls at east end of Groveland, east end of Wayland and Elmira, and the cost of additions on the central control machine were as follows:

Groveland.....	\$24,600
Wayland.....	27,500
Elmira.....	10,900
Total.....	\$63,000

Total cost of installation:

Initial installation.....	\$23,475
Additions.....	63,000
Total.....	\$86,475

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$78,475
(b) Operating Expenses.....	8,000
(c) Total.....	<u>\$86,475</u>
2. Gross Saving per Annum.....	<u>\$57,262</u>
3. Increased Annual Operating Expenses.....	5,354
4. Net Reduction in Annual Operating Expenses.....	<u>\$51,908</u>
5. Deduction for Interest Charges @ 4% (of 1-a).....	3,139
6. Net Saving per Annum.....	<u>\$48,769</u>
7. Annual Return over 4% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	62.1%
(b) On Total Cost ($6 \div 1-c$).....	56.4%

Action Recommended

Acceptance as information.

FORMULA FOR ESTIMATING TRAIN MILES SAVED
DUE TO INCREASED TONNAGE WITH
CENTRALIZED TRAFFIC CONTROL

At the 1948 Annual Meeting*, the Committee presented the first report on this subject. It included two formulae and examples based on actual centralized traffic control projects.

The economic value of the saving per freight train mile on two centralized traffic control projects has been as follows:

Case A—\$1.53 per train mile (1944)**

Case B—\$1.718 per train mile (1944) †

The values used per train mile in these two cases are the costs on the railroads where the installations were made. As these costs vary on each railroad, the Committee has, through cooperation with the Bureau of Railway Economics, A.A.R., secured similar cost data on each of the 79 railroads for the year 1947, as shown in Table I. These data are compiled from each railroad's Annual Report Form A.

The total cost per freight train mile includes the following:

1. Road freight train crews' wages.

Includes freight proportion of charges to operating accounts 392, 393 and 401.

2. Fuel, supplies, enginehouse expense and locomotive repairs.

Includes freight proportion of charges to operating expense accounts 308, 311, 394 to 400 inclusive, and 402.

3. Payroll taxes on crew wages and labor applicable to locomotive repairs and shop and enginehouse expense.

Payroll taxes calculated at rate of 8 per cent in 1947 as average for all railroads.

The total train cost for the 79 railroads, as shown in Table I, varies from a minimum of \$1.8047 to \$7.6353 per train mile, with a composite average of \$2.6509.

Where the actual train mile cost cannot be ascertained on a project, the costs listed may be of help in arriving at an estimated cost per train mile.

* A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 25 and 466.

** A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, pp. 16 and 287.

† A.A.R. Signal Section 1944 Proceedings, Vol. XLII, p. 19-A.

Sept. 1949]

Com. I—Economics of Ry. Signaling

TABLE I

Road Freight Train Crew's Wages and Specified Elements of Freight Service
Cost per Ordinary Train Mile—Calendar Year 1947

Railroad	Road freight train crew's wages a	Fuel, supplies, enginehouse expense and locomotive repairs b	Payroll taxes on crew wages and labor applicable to locomotive repairs and shop and enginehouse expense c	Total
NEW ENGLAND REGION:				
1 Bangor & Aroostook.....	90.36¢	204.32¢	11.39¢	306.07¢
2 Boston & Maine.....	90.36	150.00	11.62	251.98
3 Central Vermont.....	80.08	179.87	10.57	270.52
4 Maine Central.....	83.85	182.58	11.07	277.50
5 New York, New Haven & Hartford.....	93.04	205.26	13.08	311.38
6 Rutland.....	84.07	169.10	10.89	264.06
GREAT LAKES REGION:				
7 Grand Trunk Western.....	66.00	139.40	7.99	213.39
8 Erie (Incl. Chgo. & Erie).....	90.69	181.31	12.62	294.62
9 New York, Chicago & St. Louis.....	71.77	155.61	9.40	236.78
10 Delaware & Hudson.....	91.39	272.21	15.40	379.00
11 Delaware, Lackawanna & Western.....	95.32	177.02	11.34	283.68
12 Lehigh & New England.....	110.46	225.97	13.58	350.01
13 Lehigh Valley.....	106.79	232.58	13.97	353.34
14 Monongahela.....	133.89	174.79	15.25	323.93
15 New York, Ontario & Western.....	95.22	138.41	11.49	245.12
16 New York Central (Incl. B. & A.).....	89.61	173.89	11.82	275.32
17 Pittsburgh & Lake Erie.....	98.74	238.79	13.02	350.55
18 Ann Arbor.....	65.69	131.65	8.59	205.93
19 Wabash.....	66.06	129.18	8.59	203.83
CENTRAL EASTERN REGION:				
20 Baltimore & Ohio.....	105.18	213.20	14.63	333.01
21 Bessemer & Lake Erie.....	115.56	615.81	32.16	763.53
22 Chicago & Eastern Illinois.....	66.72	141.88	9.26	217.86
23 Chicago, Indianapolis & Louisville.....	65.87	106.31	8.29	180.47
24 Detroit, Toledo & Ironton.....	71.10	145.05	8.55	224.70
25 Elgin, Joliet & Eastern.....	172.58	195.97	18.45	387.00
26 Illinois Terminal.....	140.63	164.48	14.71	319.82
27 Long Island.....	152.72	172.83	16.30	341.85
28 Pennsylvania.....	123.24	217.05	15.51	355.80
29 Cent. R.R. of New Jersey (Incl. C. R.R. of Pa.).....	135.54	275.34	17.08	427.96
30 Reading.....	107.15	225.11	14.96	347.22
31 Western Maryland.....	102.53	267.23	15.11	384.87
32 Wheeling & Lake Erie.....	93.11	137.29	10.78	241.18
POCAHONTAS REGION:				
33 Chesapeake & Ohio (Incl. Pere M.).....	84.19	189.15	11.45	284.79
34 Norfolk & Western.....	81.12	245.26	13.13	339.51
35 Richmond, Fred'burg & Potomac.....	66.34	170.47	9.88	252.69
36 Virginian.....	97.89	273.74	16.43	388.06
SOUTHERN REGION:				
37 Atlantic Coast Line.....	72.05	126.62	8.51	207.18
38 Clinchfield.....	99.88	215.72	13.40	329.00
39 Louisville & Nashville.....	75.99	138.28	9.96	224.23
40 Nashville, Chattanooga & St. Louis.....	72.70	123.99	9.37	206.06
41 Florida East Coast.....	68.60	167.64	9.22	245.46
42 Gulf, Mobile & Ohio (Incl. Alton).....	69.39	123.26	8.94	201.59
43 Central of Georgia.....	61.94	133.51	8.08	203.53
44 Illinois Central (Incl. Y. & M. V.).....	71.03	143.40	9.30	223.73
45 Norfolk Southern.....	80.85	134.74	9.83	225.42
46 Seaboard Air Line.....	80.09	154.96	10.21	245.26
47 Alabama Great Southern.....	63.14	163.03	10.06	236.23
48 Cincinnati, New Orleans & Tex. Pac.....	61.17	140.59	9.17	210.93
49 Southern.....	66.94	137.82	9.63	214.39

a Includes freight proportion of charges to operating expense accounts 392, 393 and 401.

b Includes freight proportion of charges to operating expense accounts 398, 311, 394 to 400, inclusive, and 402.

c Payroll taxes calculated at rate of 8 per cent. Reduction from actual rate of 8.75 per cent account compensation in excess of \$300 per month.

Note.—The figures in this table are dollars and cents, i.e., 90.36¢ equals \$0.9036; 204.32¢ equals \$2.0432, etc.

TABLE I—Continued

Railroad	Road freight train crew's wages a	Fuel, supplies, enginehouse expense and locomotive repairs b	Payroll taxes on crew wages and labor applicable to locomotive repairs and shop and enginehouse expense c	Total
NORTHWESTERN REGION:				
50 Minneapolis, St. Paul & S. Ste. Marie.....	80.63¢	134.33¢	9.44¢	224.40¢
51 Chicago & North Western.....	82.51	161.78	10.77	255.06
52 Chicago, St. Paul, Mpls. & Omaha.....	80.47	164.01	9.94	254.42
53 Chicago Great Western.....	71.25	132.85	8.47	212.57
54 Chicago, Milwaukee, St. Paul & Pac.....	81.80	136.66	9.49	227.95
55 Duluth, Missabe & Iron Range.....	108.34	260.09	14.73	383.16
56 Great Northern.....	82.95	173.04	10.86	266.85
57 Minneapolis & St. Louis.....	80.86	104.97	9.50	195.33
58 Northern Pacific.....	89.47	154.05	11.41	254.93
59 Spokane, Portland & Seattle.....	102.96	153.66	11.57	268.19
CENTRAL WESTERN REGION:				
60 Atchison, Topeka & Santa Fe.....	74.69	145.40	9.72	229.81
61 Chicago, Burlington & Quincy.....	73.34	105.61	8.00	186.95
62 Colorado & Southern.....	72.56	154.78	9.41	236.75
63 Fort Worth & Denver City.....	65.84	122.47	7.73	196.04
64 Denver & Rio Grande W. (Incl. D. & S. L.)..	91.84	203.52	13.04	308.40
65 Rock Island System.....	71.35	130.65	8.56	210.56
66 Northwestern Pacific.....	121.20	126.43	12.92	260.55
67 Southern Pacific.....	116.98	231.12	16.23	364.33
68 Union Pacific.....	84.89	184.85	10.67	280.41
69 Western Pacific.....	92.05	169.48	12.23	273.76
SOUTHWESTERN REGION:				
70 Frisco Lines.....	64.30	127.35	8.02	199.67
71 Kansas City Southern.....	69.36	163.95	9.64	242.95
72 Louisiana & Arkansas.....	69.75	142.38	8.26	220.39
73 Missouri-Kansas-Texas.....	64.85	126.35	7.96	199.16
74 Gulf Coast Lines.....	75.81	133.57	9.44	218.82
75 International-Great Northern.....	68.79	133.72	8.60	211.11
76 Missouri Pacific.....	77.16	125.36	9.29	211.81
77 Texas & Pacific.....	69.97	170.39	9.92	250.28
78 St. Louis Southwestern.....	75.78	118.36	8.58	202.72
79 Texas & New Orleans.....	65.96	130.42	8.51	204.89
Composite Average.....	85.84	168.06	11.19	265.09
AVERAGES BY REGIONS:				
New England.....	89.48	181.08	11.96	282.52
Great Lakes.....	86.28	175.74	11.45	273.47
Central Eastern.....	114.64	215.37	15.00	345.01
Poahontas.....	83.47	210.15	12.18	305.80
Southern.....	71.78	139.77	9.49	221.04
Northwestern.....	83.69	153.05	10.38	247.12
Central Western.....	85.76	166.78	11.01	263.55
Southwestern.....	70.32	132.27	8.79	211.38

a Includes freight proportion of charges to operating expense accounts 392, 393 and 401.

b Includes freight proportion of charges to operating expense accounts 308, 311, 394 to 400, inclusive, and 402.

c Payroll taxes calculated at rate of 8 per cent. Reduction from actual rate of 8.75 per cent account compensation in excess of \$300 per month.

Note.—The figures in this table are dollars and cents, i.e., 90.36¢ equals \$0.9036; 204.32¢ equals \$2.0432, etc.

Action Recommended

Acceptance as information.

ADVANTAGES OF ELIMINATION OF STANDARD CODE
RULE 93 IN CENTRALIZED TRAFFIC
CONTROL TERRITORY

Many railroads have discontinued the provisions of Standard Code Rule 93 as applying to operation in signal indication territory. The advantages of such practice include:

1. Expedites road freight movements through previously designated "yard limits" by eliminating the provisions of Rule 93. The control of such territory is placed entirely under the jurisdiction of the dispatcher to regulate all main track movements, both road and yard.
2. Enables better planning and consequently more expeditious performance of yard work—yard crews have more reliable information as to road movements and, therefore, are in a position to carry out their switching work to better advantage.
3. The elimination of delays previously encountered by road freight movements through yard limit territory enables the dispatcher to better supervise and plan the entire road operation.
4. Takes away the hazard of break-in-two's caused by sudden stops in yard limits.
5. Reduces the time on the road for freight trains.
6. Makes it possible to foretell more closely the terminal or station arrival and departure time of road freights and consequent savings in time on calling crews, delivery of cars and preparation of terminal yard to receive the road freight.
7. Increases safety, since it makes yard crews responsible to protect themselves against road freights when time or work limits are exceeded.
8. Often provides the dispatcher with additional information as to movements of road trains through yard limit territory, usually points where additional time is consumed in setting out, picking up, or in passing and meeting other trains.
9. No increase in cost with yard operation. Although yard movements are controlled by dispatcher, the available work time is the same or more than with operation under Rule 93, since moves are better planned, more quickly executed, and crews are on the alert.
10. Results in better coordination of road and yard moves at points where road freight trains are more apt to encounter delay, thus bringing about an improved over-all performance for the district.

Action Recommended

Acceptance as information.

EFFECT OF VARIOUS CLASSES OF TRACK ON TAXATION

The Committee, through cooperation with the Bureau of Railway Economics, A.A.R., secured information showing the State and Local taxes per mile of track operated on each of 79 railroads for the year 1947, as shown in Table I. These taxes represent the total tax accruals other than United States Government taxes.

The State and Local taxes per mile of track operated in 1947 vary from a minimum of \$209 to a maximum of \$3,827, with a composite average for the 79 railroads of \$745.

Where signaling improvements result in the retirement of track facilities, and the estimated tax saving cannot be ascertained on a project, the information shown in Table I may assist in arriving at an estimated tax saving.

TABLE I
State and Local Taxes per Mile of Track Operated
Calendar Year 1947

Railroad	Total miles of all track operated at close of year	State and local taxes*	
		Total	Per mile of track operated
NEW ENGLAND REGION:			
1 Bangor & Aroostook.....	870	\$447,737	\$515
2 Boston & Maine.....	3,372	2,549,038	756
3 Central Vermont.....	615	137,085	223
4 Maine Central.....	1,340	854,825	638
5 New York, New Haven & Hartford.....	4,459	5,099,522	1,144
6 Rutland.....	524	136,880	261
GREAT LAKES REGION:			
7 Grand Trunk Western.....	2,145	1,016,310	474
8 Erie (Incl. Chgo. & Erie).....	5,683	5,011,693	882
9 New York, Chicago & St. Louis.....	2,928	1,893,339	643
10 Delaware & Hudson.....	1,739	1,461,123	840
11 Delaware, Lackawanna & Western.....	2,438	3,838,635	1,575
12 Lehigh & New England.....	327	177,309	542
13 Lehigh Valley.....	3,015	2,540,833	843
14 Monongahela.....	275	271,929	989
15 New York, Ontario & Western.....	357	173,827	209
16 New York Central (Incl. B. & A.).....	24,219	26,282,231	1,085
17 Pittsburgh & Lake Erie.....	1,075	987,674	919
18 Ann Arbor.....	419	193,987	463
19 Wabash.....	4,303	1,882,959	438
CENTRAL EASTERN REGION:			
20 Baltimore & Ohio.....	12,021	7,837,750	652
21 Bessemer & Lake Erie.....	576	547,611	951
22 Chicago & Eastern Illinois.....	1,619	742,133	458
23 Chicago, Indianapolis & Louisville.....	823	329,196	400
24 Detroit, Toledo & Ironton.....	690	450,472	653
25 Elgin, Joliet & Eastern.....	1,354	878,067	648
26 Illinois Terminal.....	663	377,728	570
27 Long Island.....	923	3,532,168	3,827
28 Pennsylvania.....	25,026	25,069,222	1,002
29 Cent. R.R. of New Jersey (Incl. C. R.R. of Pa.).....	1,782	3,020,191	1,695
30 Reading.....	3,399	2,751,534	810
31 Western Maryland.....	1,398	1,183,069	846
32 Wheeling & Lake Erie.....	1,011	868,273	859
POCAHONTAS REGION:			
33 Chesapeake & Ohio (Incl. Pere M.).....	9,651	9,161,162	949
34 Norfolk & Western.....	4,699	5,624,051	1,197
35 Richmond, Fred'burg & Potomac.....	481	673,284	1,400
36 Virginian.....	1,101	1,685,730	1,531

* Represents total tax accruals other than United States Government taxes.

TABLE I—Continued

Railroad	Total miles of all track operated at close of year	State and local taxes*	
		Total	Per mile of track operated
SOUTHERN REGION:			
37 Atlantic Coast Line.....	7,955	\$3,999,206	\$ 503
38 Clinchfield.....	474	830,537	1,752
39 Louisville & Nashville.....	7,916	7,140,266	902
40 Nashville, Chattanooga & St. Louis.....	1,716	1,122,224	654
41 Florida East Coast.....	1,223	818,958	670
42 Gulf, Mobile & Ohio (Incl. Alton).....	4,296	2,102,290	489
43 Central of Georgia.....	2,695	1,285,750	477
44 Illinois Central (Incl. Y. & M. V.).....	11,224	10,482,245	934
45 Norfolk Southern.....	897	244,575	273
46 Seaboard Air Line.....	5,814	2,976,366	512
47 Alabama Great Southern.....	687	651,136	948
48 Cincinnati, New Orleans & Tex. Pac.....	875	1,476,923	1,688
49 Southern.....	10,588	7,096,688	670
NORTHWESTERN REGION:			
50 Minneapolis, St. Paul & S. Ste. Marie.....	5,453	2,050,697	376
51 Chicago & North Western.....	12,299	5,302,641	431
52 Chicago, St. Paul, Mpls. & Omaha.....	2,417	1,029,658	426
53 Chicago Great Western.....	2,215	802,623	362
54 Chicago, Milwaukee, St. Paul & Pac.....	15,970	7,840,455	491
55 Duluth, Missabe & Iron Range.....	1,213	1,979,600	1,632
56 Great Northern.....	11,043	9,945,050	901
57 Minneapolis & St. Louis.....	1,766	500,089	283
58 Northern Pacific.....	10,647	7,800,255	733
59 Spokane, Portland & Seattle.....	1,271	1,152,568	907
CENTRAL WESTERN REGION:			
60 Atchison, Topeka & Santa Fe.....	21,244	15,769,074	742
61 Chicago, Burlington & Quincy.....	13,630	8,454,759	620
62 Colorado & Southern.....	1,201	568,247	473
63 Fort Worth & Denver City.....	1,173	339,532	289
64 Denver & Rio Grande W. (Incl. D. & S. L.).....	3,913	2,639,190	674
65 Rock Island System.....	11,206	4,704,945	420
66 Northwestern Pacific.....	463	165,554	358
67 Southern Pacific.....	13,317	13,284,210	998
68 Union Pacific.....	15,810	13,913,088	880
69 Western Pacific.....	1,917	1,022,645	533
SOUTHWESTERN REGION:			
70 Frisco Lines.....	6,783	3,345,113	493
71 Kansas City Southern.....	1,430	1,071,958	750
72 Louisiana & Arkansas.....	996	483,790	486
73 Missouri-Kansas-Texas.....	4,657	1,871,255	402
74 Gulf Coast Lines.....	1,668	532,328	319
75 International-Great Northern.....	1,530	399,076	261
76 Missouri Pacific.....	10,563	4,427,578	419
77 Texas & Pacific.....	2,726	1,275,441	468
78 St. Louis Southwestern.....	2,354	1,131,712	481
79 Texas & New Orleans.....	6,116	2,683,374	439
Composite Average.....	371,171	276,404,246	745
AVERAGES BY REGIONS:			
New England.....	11,180	9,225,087	825
Great Lakes.....	49,423	45,733,849	925
Central Eastern.....	51,285	47,587,414	928
Poconantas.....	15,932	17,144,227	1,076
Southern.....	56,360	40,227,164	714
Northwestern.....	64,294	38,403,636	597
Central Western.....	83,874	60,861,244	726
Southwestern.....	38,823	17,221,625	444

* Represents total tax accruals other than United States Government taxes.

Action Recommended

Acceptance as information.

TRAIN HOUR VALUE

In 1948, beginning on page 32 of the 1948 Annual Meeting Advance Notice*, the Committee presented an up-to-date report on this subject, and now wishes to revise the text under the subheading "Item 1—Wages," on page 33, to read:

Item 1—Wages.

Road freight overtime:

Road employees are paid on the basis of the miles they run. If it takes longer than a certain time to run the miles paid for, then they receive overtime in addition to payment for the mileage made.

For all employees in road freight service "eight hours or less—100 miles or less" constitute a day's work for pay purposes.

In all cases, a basic day's pay is guaranteed, no matter how few miles or hours an employee works. On the other hand, where an employee runs more than his "basic day's mileage" he is paid proportionately for each excess mile run.

Thus, all road freight employees receive a basic day's pay for runs up to 100 miles and are paid for each additional mile run at a rate which is 1/100 of the basic daily rate.

Road overtime starts on all freight runs where the time on duty exceeds the time obtained by dividing the mileage made by $12\frac{1}{2}$ miles per hour, with a minimum of 8 hours, as shown by the following examples:

Miles	Overtime starts after
90	8 hours
100	8 hours
125	10 hours
135	10 hours 48 minutes
150	12 hours
175	14 hours
180	14 hours 24 minutes

Improved methods of train operation reduce the time of trains on the road and frequently eliminate or reduce overtime wages paid train and engine crews.

The reduction in overtime hours may be forecast by the process of plotting and redispersing train movements.

The reduced number of overtime hours, having been determined for a representative test period, are then projected to an annual basis. The final step consists of multiplying the overtime hours saved by the overtime rate which determines the annual saving. Where two classes of service are involved (through freight and local freight), the rate applicable to each should be determined and used.

The hourly overtime rate is obtained by dividing the basic daily rate by 8 (hours per day) and multiplying by 1.5.

* A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 32 and 466.

To the amount thus obtained should be added payroll taxes—railroad retirement and unemployment insurance and, in addition, State taxes in some instances.

Examples of Determining Overtime Rates

Through Freights

Class of employee	No. of employees	Basic daily rate (8 hours)	Total
Engineman	1	\$13.87	\$13.87
Fireman	1	12.03	12.03
Conductor	1	12.06	12.06
Brakemen	2	10.64	21.28
Total basic day train rate.....			\$59.24
Train hour rate.....			\$ 7.40
Overtime hourly rate.....			\$11.10
Add 6 per cent for payroll taxes.....			0.67
Total overtime hourly rate.....			\$11.77

Local Freights

Engineman	1	\$14.39	\$14.39
Fireman	1	12.43	12.43
Conductor	1	12.62	12.62
Brakemen	3	11.07	33.21
Total basic day train rate.....			\$72.65
Train hour rate.....			\$ 9.09
Overtime hourly rate.....			\$13.64
Add 6 per cent for payroll taxes.....			0.82
Total overtime hourly rate.....			\$14.46

The above figures are typical for an average locomotive and at rates effective October 1, 1948. Each railroad should use rates applicable on the territory involved.

Initial and Final Terminal Delay, Road Freights

Overtime on road freight trains may result in overtime crew payments at the initial and final terminals, depending upon the wage agreements in effect at the time the study is made.

If the improved facilities expedite the terminal operations, a check of the overtime at the initial and final terminals should be made to determine the difference in overtime crew wages.

When road overtime accrues during any trip or tour of duty, in no cases will payment for both initial terminal delay and overtime be paid; but that which is the greater will be paid.

In computing road overtime, consideration should be given to the fact that in many cases engine crews are usually on duty from 30 minutes to 45 minutes longer than train crews. If switch tenders or power switches are not employed, the head brakeman is also called on duty early to handle the switches for the engine in and out of the round house leads.

Several centralized traffic control studies have shown that the initial terminal overtime saving has averaged from 10 to 40 minutes per through freight train.

Final terminal delay is computed from the time the engine reaches the designated main track switch that connects with the yard track; however, if road overtime has commenced, terminal overtime does not apply; but, instead, road overtime is paid to the point of final relief.

Initial and final terminal delay time must be checked with agreements of each railroad to obtain basis of payment.

In addition, the Committee has felt some concern about the example based on the amounts for Items 2 to 8 shown on page 36 of the 1948 Annual Meeting Advance Notice. Those amounts are for the composite average of the 82 railroads listed in Table II in last year's report, and being hypothetical are rather meaningless. The Committee has therefore prepared a new example, using the amounts for a particular railroad, Railroad A, in which are shown the amounts separately for all the items, 2 to 8, in place of grouping them in one amount. Then, as a further aid, have added the amount representing the freight train proportion for all items, which is obtained from Schedule 320 of Annual Report Form A, and have shown the number of freight train hours, obtained from Schedule 531. The division of the money amounts by the number of hours equals the amount shown in Table II for Items 2 to 8 of the cost per freight train hour and is as follows:

Railroad A

Year 1947

Freight Train Hours (Schedule 531) 1,330,050

Item	Account	Freight proportion (Schedule 320)	Cost per freight train hour
2	394 Train fuel.....	\$16,047,489	\$12.07
3	397 Water for train locomotives.....	651,012	0.49
4	398 Lubricants for train locomotives.....	405,915	0.31
5	399 Other supplies for train locomotives..	147,970	0.11
6	400 Enginehouse expense—train.....	2,825,891	2.12
7	402 Train supplies and expenses.....	4,405,666	3.31
8	308 Steam locomotive repairs—road		
	freight.....	13,382,983	10.06
	311 Other locomotive repairs—road		
	freight.....	17,004	0.01
Total.....		\$37,883,930	\$28.48

SPECIFIED ELEMENTS OF TRAIN HOUR COST PER ROAD FREIGHT TRAIN HOUR - YEAR 1946

(Excluding road freight train crews' wages)

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel, supplies, enginehouse expense and locomotive repairs	Road freight loco- motive depre- ciation	Payroll taxes on labor applicable to road freight loco. repairs & enginehouse expense <u>a</u>	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number in report	Items 2 to 8	Item 9	Item 11	Items 2 to 11
<u>NEW ENGLAND REGION:</u>				
1 Bangor & Aroostook	\$27.61	\$1.23	\$0.58	\$29.42
2 Boston & Maine	21.59	0.96	0.48	23.03
3 Central Vermont	24.39	1.05	0.42	25.86
4 Maine Central	21.87	0.67	0.41	22.95
5 New York, New Haven & Hartford	27.16	1.25	0.58	28.99
6 Rutland	17.39	0.64	0.31	18.34
<u>GREAT LAKES REGION:</u>				
7 Grand Trunk Western	26.96	1.32	0.37	28.65
8 Erie (Incl.Chgo.& Erie)	27.88	1.47	0.59	29.94
9 New York, Chicago & St. Louis	27.69	0.94	0.53	29.16
10 Delaware & Hudson	42.13	1.71	0.93	44.77
11 Delaware, Lackawanna & Western	25.77	1.83	0.43	28.03
12 Lehigh & New England	17.60	0.85	0.31	18.76
13 Lehigh Valley	34.14	1.87	0.58	36.59
14 Monongahela	12.01	0.79	0.25	13.05
15 New York, Ontario & Western	15.93	1.47	0.34	17.74
16 New York Central (Incl.B.& A.)	24.50	1.28	0.50	26.28
17 Pittsburgh & Lake Erie	34.61	1.63	0.61	36.85
18 Pere Marquette	24.06	1.26	0.40	25.72
19 Ann Arbor	20.33	0.74	0.39	21.46
20 Wabash	22.93	0.94	0.45	24.32
<u>CENTRAL EASTERN REGION:</u>				
21 Baltimore & Ohio	23.73	0.82	0.55	25.10
22 Bessemer & Lake Erie	80.76	5.26	2.37	88.39
23 Chicago & Eastern Illinois	21.66	0.95	0.49	23.10
24 Chicago, Indianapolis & Louisville	22.50	1.06	0.54	24.10
25 Detroit, Toledo & Ironton	17.41	1.26	0.25	18.92
26 Elgin, Joliet & Eastern	12.55	0.48	0.26	13.29
27 Illinois Terminal	8.45	0.61	0.14	9.20
28 Long Island	21.94	0.86	0.40	23.20
29 Pennsylvania	26.21	1.11	0.53	27.85
30 Cent.R.R.of New Jersey(Inc.CRRPa)	30.46	1.29	0.56	32.31
31 Reading	23.56	0.98	0.50	25.04
32 Western Maryland	28.14	1.63	0.59	30.36
33 Wheeling & Lake Erie	15.99	1.20	0.33	17.52
<u>POCAHONTAS REGION:</u>				
34 Chesapeake & Ohio	24.55	1.22	0.49	26.26
35 Norfolk & Western	35.20	1.67	0.76	37.63
36 Richmond, Fred'burg & Potomac	38.90	1.86	0.70	41.46
37 Virginian	27.87	2.75	0.66	31.28
<u>SOUTHERN REGION:</u>				
38 Atlantic Coast Line	19.55	0.61	0.32	20.48
39 Clinchfield	25.21	1.45	0.52	27.18
40 Louisville & Nashville	20.06	0.54	0.45	21.05
41 Nashville, Chattanooga & St. Louis	22.90	0.60	0.52	24.02
42 Florida East Coast	25.39	1.19	0.43	27.01
43 Gulf, Mobile & Ohio	23.66	1.73	0.57	25.96
44 Central of Georgia	22.64	0.80	0.42	23.86
45 Illinois Central (Incl.Y&MV)	20.77	1.16	0.39	22.32
47 Norfolk Southern	16.28	0.66	0.35	17.29
48 Seaboard Air Line	40.62	1.12	0.75	42.49
49 Alabama Great Southern	31.54	0.84	0.76	33.14
50 Cincinnati, New Orleans & Tex.Pac.	28.53	1.29	0.67	30.49
51 Southern	21.33	0.66	0.51	22.50

SPECIFIED ELEMENTS OF TRAIN HOUR COST PER ROAD FREIGHT TRAIN HOUR - YEAR 1946

(Excluding road freight train crews' wages)

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel, supplies, enginehouse expense and locomotive repairs	Road freight loco- motive depre- ciation	Payroll taxes on labor applicable to road freight loco. repairs & enginehouse expense ^a	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number in report	Items 2 to 8	Item 9	Item 11	Items 2 to 11
NORTHWESTERN REGION:				
52 Minneapolis, St. Paul & S.S. Marie	\$12.02	\$0.31	\$0.18	\$12.51
53 Chicago & North Western	19.22	1.20	0.38	20.80
54 Chicago, St. Paul, Minpls. & Omaha	17.98	0.67	0.28	18.93
55 Chicago Great Western	19.97	0.86	0.35	21.18
56 Chicago, Milwaukee, St. Paul & Pac.	19.96	0.97	0.34	21.27
57 Duluth, Missabe & Iron Range	42.35	1.06	0.87	44.28
58 Great Northern	23.05	1.01	0.48	24.54
59 Minneapolis & St. Louis	14.09	1.08	0.32	15.49
60 Northern Pacific	22.08	0.94	0.48	23.50
61 Spokane, Portland & Seattle	17.03	0.71	0.27	18.01
CENTRAL WESTERN REGION:				
62 Atchison, Topeka & Santa Fe	24.76	1.12	0.53	26.41
63 Alton	21.60	0.63	0.47	22.70
64 Chicago, Burlington & Quincy	15.97	0.99	0.27	17.23
65 Colorado & Southern	21.84	0.60	0.38	22.82
66 Fort Worth & Denver City	18.55	0.80	0.35	19.70
67 Denver & Rio Grande Western	36.00	1.57	0.88	38.45
68 Rock Island System	19.47	0.85	0.37	20.69
69 Northwestern Pacific	14.31	0.31	0.27	14.89
70 Southern Pacific	33.27	0.87	0.75	34.89
71 Union Pacific	34.62	1.27	0.61	36.50
72 Western Pacific	30.80	1.06	0.71	32.57
SOUTHWESTERN REGION:				
73 Frisco Lines	22.94	0.84	0.47	24.25
74 Kansas City Southern	28.14	0.97	0.54	29.65
75 Louisiana & Arkansas	19.89	0.68	0.38	20.95
76 Missouri-Kansas-Texas	18.46	0.75	0.34	19.55
77 Gulf Coast Lines	16.64	0.31	0.31	17.26
78 International-Great Northern	20.49	0.46	0.40	21.35
79 Missouri Pacific	19.96	0.88	0.41	21.25
80 Texas & Pacific	28.03	1.67	0.61	30.31
81 St. Louis Southwestern	20.65	0.95	0.41	22.01
82 Texas & New Orleans	21.36	0.58	0.44	22.38
Composite Average	24.41	1.04	0.50	25.95
AVERAGES BY REGIONS:				
New England	24.23	1.05	0.51	25.79
Great Lakes	25.94	1.33	0.51	27.78
Central Eastern	24.89	1.05	0.53	26.47
Pocahontas	28.89	1.52	0.60	31.01
Southern	22.51	0.83	0.47	23.81
Northwestern	20.15	0.95	0.39	21.49
Central Western	27.36	1.04	0.56	28.96
Southwestern	21.34	0.82	0.43	22.59

^a Payroll taxes calculated at 6 per cent. Reduction from actual rate of 6.5 per cent account compensation in excess of \$300 per month.

SPECIFIED ELEMENTS OF TRAIN HOUR COST PER ROAD FREIGHT TRAIN HOUR - YEAR 1947

(Excluding road freight train crews' wages)

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel, supplies, enginehouse expense and locomotive repairs	Road freight loco- motive depre- ciation	Payroll taxes on labor applicable to road freight loco. repairs & enginehouse expense <u>a</u>	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number in report	Items 2 to 8	Item 9	Item 11	Items 2 to 11
NEW ENGLAND REGION:				
1 Bangor & Aroostook	\$26.12	\$1.25	\$0.53	\$27.90
2 Boston & Maine	22.65	1.09	0.66	24.40
3 Central Vermont	27.02	1.14	0.62	28.78
4 Maine Central	24.14	0.71	0.58	25.43
5 New York, New Haven & Hartford	28.66	1.41	0.79	30.86
6 Rutland	21.65	0.71	0.53	22.89
GREAT LAKES REGION:				
7 Grand Trunk Western	27.10	1.21	0.53	28.84
8 Erie (Incl. Chgo. & Erie)	31.18	1.29	0.87	33.34
9 New York, Chicago & St. Louis	29.73	0.83	0.70	31.26
10 Delaware & Hudson	48.10	1.84	1.43	51.37
11 Delaware, Lackawanna & Western	26.66	1.82	0.56	29.04
12 Lehigh & New England	18.45	0.83	0.39	19.67
13 Lehigh Valley	40.38	1.94	0.94	43.26
14 Monongahela	12.23	0.59	0.32	13.14
15 New York, Ontario & Western	17.27	1.52	0.48	19.27
16 New York Central (Incl. B. & A.)	26.49	1.22	0.71	28.42
17 Pittsburgh & Lake Erie	35.80	1.29	0.77	37.86
18 Ann Arbor	21.19	0.64	0.54	22.37
19 Wabash	25.17	1.00	0.65	26.82
CENTRAL EASTERN REGION:				
20 Baltimore & Ohio	26.17	0.74	0.76	27.67
21 Bessemer & Lake Erie	84.60	4.55	3.15	92.30
22 Chicago & Eastern Illinois	24.36	0.87	0.67	25.90
23 Chicago, Indianapolis & Louisville	18.67	1.81	0.53	21.01
24 Detroit, Toledo & Ironton	20.02	1.08	0.39	21.49
25 Elgin, Joliet & Eastern	12.72	0.38	0.30	13.40
26 Illinois Terminal	12.82	0.78	0.27	13.87
27 Long Island	20.18	0.72	0.48	21.38
28 Pennsylvania	28.22	1.13	0.73	30.08
29 Cent. R.R. of New Jersey (Incl. CRRPa)	34.94	1.46	0.79	37.19
30 Reading	28.66	1.11	0.81	30.58
31 Western Maryland	27.73	1.57	0.72	30.02
32 Wheeling & Lake Erie	15.50	0.88	0.38	16.76
POCAHONTAS REGION:				
33 Chesapeake & Ohio (Incl. Pere M.)	28.48	1.21	0.71	30.40
34 Norfolk & Western	38.66	1.45	1.05	41.16
35 Richmond, Fred'burg & Potomac	42.09	2.48	1.09	45.66
36 Virginian	32.38	2.32	1.02	35.72
SOUTHERN REGION:				
37 Atlantic Coast Line	20.20	0.69	0.44	21.33
38 Clinchfield	27.92	1.24	0.70	29.86
39 Louisville & Nashville	21.05	0.49	0.59	22.13
40 Nashville, Chattanooga & St. Louis	23.57	0.59	0.68	24.84
41 Florida East Coast	29.12	1.31	0.65	31.08
42 Gulf, Mobile & Ohio (Incl. Alton)	22.13	3.30	0.61	26.04
43 Central of Georgia	24.40	0.88	0.57	25.85
44 Illinois Central (Incl. Y&MV)	24.14	1.18	0.61	25.93
45 Norfolk Southern	20.34	0.92	0.51	21.77
46 Seaboard Air Line	26.31	1.03	0.64	27.98
47 Alabama Great Southern	32.84	2.19	1.01	36.04
48 Cincinnati, New Orleans & Tex. Pac.	29.96	1.67	0.91	32.54
49 Southern	23.25	1.07	0.72	25.04

SPECIFIED ELEMENTS OF TRAIN HOUR COST PER ROAD FREIGHT TRAIN HOUR - YEAR 1947

(Excluding road freight train crews' wages)

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel, supplies, enginehouse expense and locomotive repairs	Road freight loco- motive depre- ciation	Payroll taxes on labor applicable to road freight loco. repairs & enginehouse expense ^a	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number in report	Items 2 to 8	Item 9	Item 11	Items 2 to 11
NORTHWESTERN REGION:				
50 Minneapolis, St. Paul & S.S. Marie	\$22.54	\$0.60	\$0.50	\$23.64
51 Chicago & North Western	22.54	1.20	0.58	24.32
52 Chicago, St. Paul, Minpls. & Omaha	20.79	0.74	0.44	21.97
53 Chicago Great Western	21.76	0.87	0.45	23.08
54 Chicago, Milwaukee, St. Paul & Pac.	20.93	1.02	0.45	22.40
55 Duluth, Missabe & Iron Range	42.69	0.76	0.99	44.44
56 Great Northern	26.77	1.02	0.65	28.44
57 Minneapolis & St. Louis	14.97	1.40	0.43	16.80
58 Northern Pacific	25.26	1.24	0.70	27.20
59 Spokane, Portland & Seattle	19.90	0.71	0.43	21.04
CENTRAL WESTERN REGION:				
60 Atchison, Topeka & Santa Fe	28.18	1.21	0.72	30.11
61 Chicago, Burlington & Quincy	17.41	1.05	0.35	18.81
62 Colorado & Southern	25.60	0.60	0.60	26.80
63 Fort Worth & Denver City	22.32	0.65	0.45	23.42
64 Denver & Rio Grande W. (Incl. D&SL)	33.87	1.83	0.95	36.65
65 Rock Island System	22.56	0.91	0.49	23.96
66 Northwestern Pacific	13.23	0.28	0.34	13.85
67 Southern Pacific	35.81	0.98	1.06	37.85
68 Union Pacific	36.46	1.47	0.76	38.69
69 Western Pacific	33.96	1.42	0.98	36.36
SOUTHWESTERN REGION:				
70 Frisco Lines	24.85	0.88	0.56	26.29
71 Kansas City Southern	30.68	1.88	0.77	33.33
72 Louisiana & Arkansas	21.98	0.62	0.41	23.01
73 Missouri-Kansas-Texas	23.31	0.93	0.51	24.75
74 Gulf Coast Lines	21.59	0.38	0.55	22.52
75 International-Great Northern	24.73	0.49	0.57	25.79
76 Missouri Pacific	22.37	0.81	0.56	23.74
77 Texas & Pacific	31.63	1.31	0.80	33.74
78 St. Louis Southwestern	22.99	0.86	0.49	24.34
79 Texas & New Orleans	25.74	0.60	0.64	26.98
Composite Average	26.68	1.10	0.69	28.47
AVERAGES BY REGIONS:				
New England	25.59	1.15	0.68	27.42
Great Lakes	28.31	1.26	0.73	30.30
Central Eastern	26.99	1.04	0.73	28.76
Pocahontas	31.97	1.39	0.84	34.20
Southern	23.28	1.04	0.63	24.95
Northwestern	23.25	1.02	0.56	24.83
Central Western	29.61	1.17	0.74	31.52
Southwestern	24.58	0.85	0.59	26.02

^a Payroll taxes calculated at 8 per cent. Reduction from actual rate of 8.75 per cent account compensation in excess of \$300 per month.

The Committee also presents revised Table II, for 79 railroads, for the year 1947, superseding Table II following page 36 of the 1948 Annual Meeting Advance Notice.

It is the intention next year to revise and print the complete report to include these changes and additions.

Action Recommended

Acceptance as information.

ECONOMICS OF COMMUNICATION BETWEEN FRONT AND
REAR END AND BETWEEN ENGINES, TRAINS AND
FIXED POINTS*

Space radio for end to end communication is provided on 15 locomotives and 15 cabooses assigned to through freight train service on the Missouri Pacific R.R.** between McGehee, Ark., and Alexandria, La., a distance of 193 miles.

Inductive carrier system communication is provided on the 15 cabooses and at 7 wayside continuous telegraph stations along the route. Power for wayside stations is secured from local power circuits. The distance between these wayside stations varies from 21 to 49 miles.

Two systems are used because the conductor is, for the most part, responsible for the operation of a train with respect to matters involving communication with wayside offices. If any information is to be passed back and forth between the conductor and the enginemen, this conversation is separate and apart from the communications between the conductor and the operators in wayside offices. A further advantage of having the two separate systems is that the operation of the loudspeaker in a locomotive is confined primarily to calls for the engineman on that locomotive, thus requiring a minimum of attention on the part of the enginemen. On the other hand, in a caboose the conductor and at least one trainman are available to listen to the loudspeaker and to answer calls at any time. The train radio is not used for handling train orders.

The installation of the train communication equipment, both space radio and inductive carrier, was completed in September 1947.

The 193-mile subdivision was selected because the volume of traffic throughout the year is sufficiently uniform so that 15 locomotives for through freight service can definitely be assigned to this territory; also because this territory includes a variation of local conditions: level track with few curves on 73 miles between McGehee, Ark. and Collinston, La., rolling grades and some curves on 21 miles between Collinston and Monroe, La., level straight track on 25 miles between Monroe and Riverton, La., and rolling grades and curves on 73 miles between Riverton and Alexandria, La. Train movements are authorized by time-table and train orders on the 73 miles between McGehee and Collinston, and by time-table and train order, with automatic block protection on the 120 miles between Collinston and Alexandria. This section also handles through passenger trains. Freight trains up to 100 cars in length are readily handled by the locomotives.

Under normal operations, through freight trains made no overtime on this territory. Overtime occurs only when normal operation is disrupted due to derailment, doubling of hill, engine failure, or other unforeseen happening. Therefore, no credit is taken or monetary saving estimated, although the use of radio undoubtedly will reduce overtime in such instances.

* Previous report on this subject appears in A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, pp. 47-56.

** *Railway Signaling*, March 1948, p. 153.

Comparative Statement

In the following statement, October 1947 was selected for the reason that it was the first full month all radio stations were in service. January 1946 was selected as the month without radio for the comparison, as the total cars handled over the territory was nearly the same as during October 1947. While fewer trains were operated during October 1947 than during January 1946, more cars were handled per train which offsets, to some degree, the operating benefits derived from the fewer number of trains.

The 193-mile territory is divided—99 miles in the Louisiana Division and 94 miles in the Little Rock Division.

	Before Radio (January 1946)		After Radio (October 1947)	
	Louisiana Division	Little Rock Division	Louisiana Division	Little Rock Division
Miles per freight train hour (through freight).....	19.7	22.9	21.3	23.8
Number of trains (through freight).....	387	340	337	279
Total number of cars (through freight).....	29,800	29,917	25,274	24,961
Train hours on road (miles in Division ÷ miles per freight train hour).....	5.025	4.104	4.647	3.949

During the first 10 months of 1947, a check indicates that there were 256 hot boxes detected and set out on line. Of these, it is reasonable to assume that half were detected from the rear of the train and would have resulted in air being applied from caboose. There is the possibility of break-in-two when setting air from rear of train and the possibility of derailment due to drawbar or draft rigging falling in track.

*Operating Advantages**Train to train.*

When meeting or passing trains, attention can be called to hot boxes, shifted loads or otherwise bad order cars, eliminating possibility of misunderstanding hand signals.

Notifying following train of circumstances which may make it desirable for following train to hold back, also to advise them when first train is again on the move.

Understanding with following train as to where service stop will be made by train ahead so as to avoid delay.

After sending out flagman, conductor can notify following train of location of his train which has stopped on main track.

Has proven very helpful where trains are doubling hills when there is more than one train involved in the doubling.

End to end.

Facilitates terminal air test before departure of train, *i.e.*, car inspector watching air gage in caboose and advising engineman relative to air test and regarding any bad orders in train.

Conductor can use to check in full crew at initial terminal.

Conductor can advise engineman when train is complete and ready to depart.

Conductor can advise engineman proximity of caboose to switch when heading into or out of siding and thus eliminate the guess work on the part of engineman as to when train is in clear, and brakeman on caboose or on leaving when train is entirely on main track, siding switch closed, and brakeman on caboose.

If siding is not long enough to clear train, this can be determined quickly and necessary flagging arrangements made promptly.

Check of train orders to verify understanding of meeting and waiting points.

Engineman can notify conductor in advance of service stops (water and fuel) and reason for running at reduced speed (yellow blocks) or train stop (red block, flagged, engine in trouble, or hot box).

Breaks-in-two are reduced by engineman being notified of hot boxes or brakes sticking near rear of train, or trainman being left at switch, etc., which would require air being set from rear.

Engineman can advise conductor when train to be met is in the clear and then proceed eliminating possibility of conductor setting air from caboose to stop train short of fouling point.

Conductor can call engineman's attention to excessive speed, or request increased speed if desirable.

Conductor can be advised of unscheduled stop.

Engineman can immediately acquaint conductor of change in wait order, meeting point, or additional time given his train.

Makes possible communication between head and rear of train when conditions would not permit passing of visual signals.

Insures there being a common understanding of train orders, time-table, and special instruction requirements.

Permits planning and coordination by the entire crew of work, such as picking up, setting out, closing vents on refrigerators, etc., which it may be necessary to do on the trip.

Has eliminated necessity of pulling air from the rear except in case of derailment.

Between train and station.

Elimination of delay at initial stations when "no bills" are found in train or when car inspector has found bad order car that has to be set out by car inspector using radio to contact yard office.

Conductor can notify operator of any unusual delays, which information can be relayed to dispatcher to assist him in taking advantage of such information.

Operator can give train crew information which will avoid delay in setting out or picking up cars.

Operator can notify train crew of hot box, brake sticking, shifted load, or otherwise unsafe condition noted in passing train to enable the taking of immediate action by engineman.

Through the operator, dispatcher can be advised when train begins to move, when train is delayed, of train accident or other emergencies and can summon relief when necessary and plan his train movements accordingly.

Information can be conveyed to dispatcher as to where train will go for opposing superior train on schedule or train order. With this information, dispatcher can arrange subsequent meeting points so that the least possible delay will result.

Operator can advise of "call-on" signal being displayed to permit movement down main track to pick up train order granting additional time, etc.

Train crew can be advised as to track to use in terminal or relating to work to be done on line of road.

Issue instructions to trains on short notice reference work to be done.

Conductor can advise wayside station that certain waybills for cars have not been furnished. Such waybills may then be forwarded by passenger train to overtake the shipment.

Can advise trains of sidings being occupied to avoid "saws."

Action Recommended

Acceptance as information.

(Revision of A.A.R. Signal Section Form 24)
A.A.R. SIGNAL SECTION FORM 24.

ECONOMIC STATEMENT

1. Cost of Installation:
 - (a) Capital Investment..... \$.....
 - (b) Operating Expenses.....
 - (c) Total..... \$.....
2. Gross Saving per Annum..... \$.....
3. Increased Annual Operating Expenses.....
4. Net Reduction in Annual Operating Expenses..... \$.....
5. Deduction for Interest Charges @% (of 1-a).....
6. Net Saving per Annum..... \$.....
7. Annual Return over% Interest:
 - (a) On Capital Investment ($6 \div 1-a$)..... %
 - (b) On Total Cost ($6 \div 1-c$)..... %

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter
in the Manual.

Subject-matter to be Superseded

A.A.R. Signal Section Form 24—Economic Statement,
Manual Part 29.

SUMMARY OF ECONOMIC RESULTS
JANUARY 1, 1948*

Type	No. of installa- tions	Total cost	Net saving Per year	Per cent
Automatic block signals.....	8	\$ 3,046,928	\$ 561,045	18.4
Interlockings:				
(a) Manually operated.....	7	253,467	150,618	59.4
(b) Consolidation of inter- lockings.....	24	1,133,460	246,271	21.7
(c) Automatic.....	74	531,361	337,660	63.5
Train operation by signal indi- cation.....	3	138,000	52,701	38.2
Remote control.....	37	726,678	231,631	31.8
Centralized traffic control.....	26	7,818,595	2,140,355	27.4
Car retarders.....	16	8,850,000	3,470,603	39.2
Railroad highway grade crossing protection.....	269	771,344	338,302	43.9
Grand total.....	464	\$23,269,833	\$7,529,186	32.4

Action Recommended

Acceptance as information.

* Revision of Table XXIV appearing on page 80 of Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.

RAILROAD-HIGHWAY GRADE CROSSINGS EQUIPPED
WITH GATES, WATCHMEN AND SIGNALS
IN THE UNITED STATES*,
DECEMBER 31, 1946†

Type	Number	Total
Gates, with or without other protection operated 24 hours per day.....	3,079	
Gates, with or without other protection operated less than 24 hours per day.....	1,054	4,133
Watchmen, alone or with protection other than gates, on duty 24 hours per day.....	1,295	
Watchmen, alone or with protection other than gates, on duty less than 24 hours per day.....	3,237	4,532
Both audible and visual signals, without other protection.....	12,615	
Audible signals only.....	2,579	
Visual signals only.....	9,461	24,655
Total protected crossings.....		33,320

Action Recommended

Acceptance as information.

* I.C.C. "Statistics of Railways in the United States."

† Revision of Table XXI appearing on page 76 of Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices. Previous report appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 39 and 467.

TYPES OF PROTECTION AT RAILROAD HIGHWAY
GRADE CROSSINGS IN THE UNITED STATES*,
DECEMBER 31, 1945 and 1946†

Type of protection	1945	1946
Gates.....	4,108	4,133
Watchmen.....	4,717	4,532
Signals.....	24,496	24,655
Total protected crossings.....	33,321	33,320
Fixed signs.....	184,015	183,943
Otherwise unprotected.....	8,817	8,880
Grand total.....	226,153	226,143

Action Recommended

Acceptance as information.

* I.C.C. "Statistics of Railways in the United States."

† Revision of Table XX appearing on page 75 of Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices. Previous report appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 38 and 467.

SPRING SWITCHES IN SERVICE IN THE UNITED STATES
AS OF JANUARY 1, 1948*

	Total number
Classification as to territory:	
Automatic block.....	4,426
Manual block.....	238
Centralized traffic control.....	163
Non-block.....	948
Interlocking.....	189
Yard.....	560
Total.....	6,524
Classification as to application:	
End of siding.....	4,154
End of two tracks.....	618
Junction.....	248
Yard tracks.....	830
Other tracks.....	674
Total.....	6,524
Number equipped with:	
Facing point locks.....	1,699
Electric locks.....	19
Total.....	1,718
Number of protecting signals:	
High signals.....	9,120
Low signals.....	3,279
Total.....	12,399

Action Recommended

Acceptance as information.

* I.C.C. Tabulation of Statistics, Table No. 10.

(New table for inclusion in Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.)

Sept. 1949]

Com. I—Economics of Ry. Signaling

AGGREGATE LENGTH OF LINES AND PARTS OF LINES ON
WHICH THE AUTOMATIC BLOCK SIGNAL SYSTEM,
AUTOMATIC TRAIN STOP, AUTOMATIC TRAIN
CONTROL, AUTOMATIC CAB SIGNAL DEVICES
AND CENTRALIZED TRAFFIC CONTROL
WERE IN USE—JANUARY 1, 1908-1948*

Year Jan. 1	Automatic block signals, miles of track	Automatic train stop, train control and cab signal devices, miles of track	Centralized traffic control, miles of track
1908	18,524.1		
1909	20,555.9		
1910	23,811.4		
1911	29,202.4		
1912	33,425.4		
1913	36,934.3	41.8	
1914	44,461.2	68.9	
1915	49,442.1	287.7	
1916	51,119.7	287.2	
1917	53,799.8	279.6	
1918	57,083.6	283.7	
1919	59,458.2	286.2	
1920	60,992.3	300.4	
1921	61,744.5	344.4	
1922	62,444.9	344.3	
1923	63,718.7	323.3	
1924	65,844.6	824.6	
1925	69,127.8	1,399.1 (f)	
1926	71,698.4	3,124.1 (a) (f)	
1927	76,994.0	7,404.4 (b) (f)	43.5 (e)
1928	82,064.8	19,647.1 (c)	78.9 (e)
1929	85,890.8	20,215.8 (d)	353.5 (e)
1930	90,249.0	20,405.9	341.1 (f)
1931	93,806.4	20,474.8	554.4 (f)
1932	94,838.2	20,554.0	892.8 (f)
1933	94,212.3	20,576.9	987.3 (f)
1934	93,449.3	19,905.4	1,326.6 (f)
1935	93,469.7	19,778.9	1,706.3
1936	93,401.5	19,769.7	1,755.2
1937	93,757.1	19,774.6	1,834.4
1938	94,883.4	20,160.2	1,975.0
1939	95,344.5	20,424.6	2,051.3

* I.C.C. Tabulation of Statistics, Tables Nos. 1-5 A and C, and 7.

(New table for inclusion in Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.)

Year Jan. 1	Automatic block signals, miles of track	Automatic train stop, train control and cab signal devices, miles of track	Centralized traffic control, miles of track
1940	95,887.2	20,449.7	2,143.0
1941	96,459.4	20,580.0	2,406.5
1942	97,361.0	20,578.4	2,702.8
1943	98,369.5	20,563.0	3,591.8
1944	98,878.3	20,723.9	4,746.5
1945	99,736.3	20,722.7	6,108.5
1946	101,519.3	20,720.1	7,383.9
1947	103,167.0	20,726.5	8,467.5
1948	105,338.8	20,747.0	9,971.5

Notes:

- (a) As of April 1, 1926.
- (b) As of July 1, 1927.
- (c) As of July 1, 1928.
- (d) As of July 1, 1929.
- (e) From *Railway Signaling*.
- (f) Miles of road.

Action Recommended

Acceptance as information.

Sept. 1949]

Com. I—Economics of Ry. Signaling

**ANNUAL MAINTENANCE, OPERATION, AND INVESTMENT
CHARGES FOR RAILWAY SIGNALS AND INTERLOCKINGS
ON CLASS I RAILROADS, U.S.A.—1908-1947***

Year	Maintenance of signals and interlockings Account 249	Operation of signals and interlockings Account 404	Investment in road and equipment Account 27	Total
1908	\$ 7,634,672	\$ 8,566,123	\$ a	\$ 16,200,795
1909	6,637,407	8,299,333	a	14,936,740
1910	8,175,641	8,718,693	a	16,894,334
1911	10,134,773	9,392,601	a	19,527,374
1912	9,633,232	9,907,719	a	19,540,951
1913	11,214,704	10,648,292	a	21,862,996
1914	11,675,102	11,374,397	a	23,049,499
1915	9,906,160	11,185,653	a	21,091,813
1916	10,390,023	12,101,059	a	22,491,082
1917	12,692,292	14,705,552	9,413,462	36,811,306
1918	21,289,190	21,266,077	8,439,703	50,994,970
1919	24,677,650	25,933,171	8,426,702	59,037,523
1920	28,580,710	30,195,124	4,105,691	62,881,525
1921	23,570,382	27,688,339	3,179,300	54,438,021
1922	23,948,595	25,311,355	4,994,411	54,254,361
1923	26,037,386	25,454,221	10,807,839	62,299,446
1924	26,944,836	26,223,176	14,827,926	67,995,938
1925	30,047,620	26,181,209	15,666,666	71,895,495
1926	31,208,948	26,251,705	27,210,830	84,671,483
1927	32,847,323	26,153,282	32,203,889	91,204,494
1928	32,156,729	25,973,666	16,877,611	75,008,006
1929	35,140,858	26,302,969	26,674,350	88,118,177
1930	32,286,720	25,516,185	23,194,438	80,997,343
1931	25,277,833	22,440,088	12,583,113	60,301,034
1932	16,771,739	18,420,198	2,906,029	38,097,966
1933	14,536,418	17,029,771 CR	1,058,346	30,507,843
1934	16,214,442	17,768,538	601,568	34,584,548
1935	16,954,758	19,173,116	2,934,878	39,062,752
1936	21,576,830	19,675,019	1,349,293	42,601,142
1937	24,396,138	20,393,337	5,522,032	50,311,507
1938	21,087,101	20,574,386	3,696,067	45,357,554
1939	23,123,720	20,337,984	1,947,304	45,409,008

* Years 1908 to 1919 inclusive, and 1938 to 1947 inclusive, furnished by Bureau of Railway Economics, A.A.R., Washington, D. C. Years 1920 to 1937 inclusive, taken from I.C.C. Annual Reports on the Statistics of Railways in the U.S.A.

(New table for inclusion in Chapter III—Principles and Economics of Signaling, American Railway Signaling Principles and Practices.)

Year	Maintenance of signals and interlockings Account 249	Operation of signals and interlockings Account 404	Investment in road and equipment Account 27	Total
1940	\$26,237,051	\$20,525,620	\$ 3,782,917	\$ 50,545,588
1941	30,894,828	21,473,350	4,594,277	56,962,455
1942	35,773,504	24,073,283	5,889,184	65,735,971
1943	37,578,916	25,776,787	10,046,939	73,402,642
1944	43,109,701	28,636,617	13,673,043	85,419,361
1945	44,609,126	28,248,314	28,727,260	101,584,700
1946	47,269,216	32,190,887	20,766,037	100,226,140
1947	49,447,167	34,106,012	29,184,457	112,737,636

Notes:

Foregoing figures cover line-haul Class I railroads only, not including switching and terminal companies.

Figures in column headed "Investment in road and equipment" represent net charges for the year, that is, gross charges minus retirements. Figures not available for (a). Years 1908 to 1916 inclusive, end June 30th. Years 1917 to 1947 inclusive, end December 31st.

The foregoing information was compiled with the help of the Bureau of Railway Economics, A.A.R. It is useful because of the cost story it reflects. Following are some of the interesting features:

For the period 1908 to 1922, operation charges were generally higher than maintenance charges, while from 1923 to 1931, operation charges were less although there was a great increase in new signaling.

The charges dropped off as a result of the war period, around 1920, and showed an increase after 1922 after the roads were returned to private control.

From 1922 to 1935 the new signaling included remote control, centralized traffic control, car retarders, and extensive signaling and train control programs, but in spite of large expenditures, the cost of maintenance only slightly increased and the cost of operation actually decreased.

Over 10 times the amount of new signaling was installed in 1927 as compared with 1921.

The decrease in charges from 1930 to 1933 was the result of the drop in railroad traffic during that period, while all the curves show an upturn since 1933.

The investment charges in 1935 were less than 1921 while the maintenance, operation and total charges in 1935 were less than in 1918.

Signal charges on account of crossing protection, telegraph and telephone lines, joint yards and terminals, yard supplies and expenses, tools, and probably some train control charges, have not been included.

Action Recommended

Acceptance as information.

ECONOMICS OF PRECAST MATERIAL FOR SIGNAL WORK

On September 29, 1948 a questionnaire (Inquiry SS-82A) was issued to 148 Voting Representatives (1,144 votes) of Member Roads in the Signal Section, requesting cost figures for field-poured concrete in comparison with precast concrete or cast iron for foundations in accordance with A.A.R. Sig. Sec. 1080, 1081, 1107, 1259, 1687 and 1694.

Replies were received from 52 railroads representing 34.4 per cent of the total (46.6 per cent of votes) shown above. Replies from 26 of the 52 railroads (144 votes) were signed and returned blank except several advised they could not furnish cost data and a few advised they did not use precast concrete. The other 26 replies (399 votes) in some cases showed cost figures for field-poured concrete with no figures for precast concrete or vice-versa, therefore accompanying Table I only lists the 17 railroads (303 votes) that furnished the comparative cost figures.

The railroads shown in Table I are in the following districts and regions:

Eastern District:	Great Lakes Region	(3)
	Central Eastern Region	(3)
Southern District:	Pocahontas Region	(1)
Western District:	Central Western Region	(2)
	Southwestern Region	(2)

Explanatory.

The column "Cost of Erecting Facility on Foundation" was explained in the questionnaire as follows:

"It is thought that this column will bring out the difference in cost between immediately erecting the facility on a precast foundation vs. sending gang back later to erect the facility on field-poured foundation after it has set."

Analysis of this column in the Table shows 13 out of 25 cases where the cost was the same for either field-poured or precast foundation and 2 cases where the cost of erection was greater for the precast than the field-poured foundation. However, the average savings in 10 cases shows a 56.8 per cent saving where the facility was erected on precast foundation.

There are probably some errors in the number of cubic yards of material reported, as A.A.R. Sig. Sec. 1107 nominally requires approximately 1.33 cubic yards of material and it will be noted the quantity reported runs from a minimum of 0.953 to 2.4 cubic yards.

Analysis of the "Total Cost" column shows a 26.4 per cent average saving in 20 cases out of 25 in the use of precast concrete, the saving ranging from a minimum of 2.56 per cent to 55 per cent.

The Committee has no explanation for the variations in the other columns as they are typical of information obtained by use of the questionnaire.

Conclusion.

The Committee is of the opinion that in view of the saving shown in this report, a further study of the use of precast vs. field-mixed concrete is warranted by those roads having new projects involving a number of concrete foundations.

Action Recommended

Acceptance as information.

TABLE I

Economics of Precast Material for Signal Work

R.R.	A.A.R. Drawing No.	Foundation for	Type	Cu. Yd.	Material Cost	Cost of trans.	Cost of forms	Cost of excavating and installing	Cost of erecting facility	Total cost	Precast saving Money	%
A	1107D	Ground mast signal	F.P.	2.3	\$20.01	\$2.63	\$14.00	\$14.56	\$18.20	\$ 69.40		
			P.C.	—	23.25	2.63	—	14.56	10.92	51.36	\$18.04	26
B	"	"	F.P.	2.4	26.40	—	2.80	51.30	5.60	86.10		
			P.C.	—	24.75	1.15	—	7.25	5.60	38.75	47.35	55
C	"	"	F.P.	2	16.76	35.40	9.96	22.18	21.76	106.06		
			P.C.	3	*49.29	—	—	12.93	22.18	84.40	21.66	20.4
D	"	"	F.P.	1.33	29.60	12.80	11.40	14.60	34.00	102.40		
			P.C.	0.6	53.45	6.30	—	7.00	15.00	81.75	20.65	20.2
E	"	"	F.P.	2.5	12.82	5.00	**	28.75	12.50	59.07		
			P.C.	—	25.36	2.00	—	8.75	12.50	48.61	10.46	17.7
F	"	"	F.P.	0.953	5.72	0.50	0.30	11.53	5.00	23.05		
			P.C.	0.953	5.72	0.50	—	4.00	3.00	13.22	9.83	42.6
G	"	"	F.P.	1.25	7.38	0.51	0.20	7.50	1.00	16.59		
			P.C.	1.25	48.35	0.51	—	2.50	1.00	52.36		
H	"	"	F.P.	1.33	8.00	1.00	6.00	30.00	10.00	55.00		
			P.C.	—	29.40	2.85	—	10.00	10.00	52.25	2.75	5
I	"	"	F.P.	1.8	19.37	4.40	6.34	12.80	14.60	57.51		
			P.C.	—	22.00	1.77	—	22.00	18.00	63.77		
J	"	"	F.M.	1.33	11.34	4.37	0.90	32.59	5.00	54.20	Note	
			T.M.	—	14.04	—	0.90	9.65	5.00	29.59	"A"	

A	1259C	Instrument cases	F.P.	2.5	21.55	2.63	16.00	14.56	18.20	72.94		
			P.C.	—	27.73	2.63	—	14.56	10.92	55.84	17.10	23.4
B	"	"	F.P.	3.2	35.20	—	3.60	60.60	2.50	101.90		
			P.C.	—	39.80	3.30	—	14.10	2.50	59.70	42.20	41.4
D	"	"	F.P.	1.36	30.20	12.80	11.50	14.60	20.50	89.60		
			P.C.	0.4	50.60	5.90	—	7.00	3.50	67.00	22.60	25.2
D	"	"	F.P.	1.36	30.20	12.80	11.50	14.60	20.50	89.60		
			C.I.	—	72.80	5.00	—	6.00	3.50	87.30	2.30	2.6
E	"	"	F.P.	3.5	17.40	7.00	**	37.50	17.50	79.40		
			P.C.	—	34.91	2.00	—	8.75	17.50	63.16	16.24	20.5
F	"	"	F.P.	1.47	8.82	0.50	0.40	17.70	6.00	33.42		
			P.C.	1.47	8.82	0.50	—	5.00	4.00	18.32	15.10	45.2
G	"	"	F.P.	1.25	7.38	0.51	0.20	7.50	1.00	16.59		
			P.C.	1.25	48.35	0.51	—	2.50	1.00	52.36		
B	1687B	Highway	F.P.	4.4	48.40	—	4.00	65.20	11.20	128.80		
		Xing Signal	P.C.	—	46.83	—	3.30	16.00	11.20	77.33	51.47	39.9
D	"	"	F.P.	3.8	81.00	23.80	12.00	34.00	34.00	184.80		
			P.C.	1.0	84.60	15.60	—	22.00	15.00	137.20	47.60	25.8
E	"	"	F.P.	1.0	5.19	2.00	**	12.50	17.50	37.19		
			P.C.	—	25.36	2.00	—	8.75	17.50	53.61		
G	"	"	F.P.	1.25	7.38	0.51	0.20	7.50	1.00	16.59		
			P.C.	1.25	48.35	0.51	—	2.50	1.00	52.36		
J	"	"	F.M.	0.44	3.78	1.46	0.35	12.60	3.75	21.94	Note	
			T.M.	—	4.68	—	0.35	7.20	3.75	15.98	"A"	

Note "A"—Shows comparison between use of field-mixed and transit-mixed concrete.

(Concluded on next page)

TABLE I—Continued

R.R.	A.A.R. Drawing No.	Foundation for	Type	Cu. Yd.	Material Cost	Cost of trans.	Cost of forms	Cost of excavating and installing	Cost of erecting facility	Total cost	Precast saving Money	%
D	1694A	4-inch mast	F.P.	0.4	\$11.00	\$7.40	\$5.80	\$8.00	\$12.00	\$44.20		
			P.C.	0.4	25.00	2.45	—	4.00	6.00	37.45	\$ 6.75	15.3
F	"	"	F.P.	0.44	2.64	0.50	0.25	6.40	5.00	14.79		
			P.C.	0.44	2.64	0.50	—	4.00	3.00	10.14	4.65	31.4
K	"	"	F.P.	0.28	3.00	2.00	5.00	15.00	20.00	45.00		
			P.C.	0.28	4.00	2.00	—	8.00	20.00	34.00	11.00	24.4
D	1080B	Pipe	F.P.	*0.074	1.48	1.00	1.60	2.50	1.20	7.78		
		carriers	P.C.	0.074	3.60	0.50	—	1.30	1.20	6.60	1.18	15.1
D	1081B	Air	F.P.	*0.022	1.48	0.80	1.60	2.50	0.90	7.28		
		pipe lines	P.C.	0.022	4.00	0.40	—	1.05	0.90	6.35	0.93	12.8

Legend * Precast by railroad forces
 ** Forms are reused
 F.P. Field-poured
 P.C. Precast
 C.I. Cast iron
 F.M. Field-mixed
 T.M. Transit-mixed

ECONOMICS OF DRAGGING EQUIPMENT DETECTORS

Since the use of dragging equipment detectors is not yet sufficiently widespread among Member Roads to employ a questionnaire, data was secured from an Eastern railroad having extensive installations. Information so obtained is set forth below.

This particular road has been progressively installing dragging equipment detectors since 1936, with result that it now has 283 interlocking locations or drawbridges protected by dragging equipment detectors installed on 616 tracks.

Since the first installation in 1936, there have been approximately 27,000 detector actuations—about 33 per cent of which were caused by dragging brake riggings, broken trucks, broken wheels, broken truck parts, ash pans down, water scoops down, and steam heat connections down, any one of which under certain conditions could have resulted seriously. Balance of actuations came from generator belts, scrap iron, loose lading, coal, ice, and other miscellaneous or unknown causes.

From experience on this road prior to 1936, when a number of costly train accidents at interlockings were attributed to brake riggings down, which dragged into interlocked switches, it is quite apparent that many of the defects causing actuations in the first mentioned group above were potentially of a serious nature. Unquestionably the installation of detectors in track has tremendously reduced the number of derailments which otherwise might have occurred. The initial installation costs and subsequent maintenance costs have afforded a protection which potentially saves substantial sums in operating expenses.

Following is a summary of actuations up to and including the year 1948:

Dragging Equipment Detector Data on an Eastern Railroad

Year	Locations protected	Tracks equipped	Actuations	Average actuations per track equipped
1936	4	13	67	5.15
1937	28	63	267	4.23
1938	80	92	686	7.45
1939	97	246	1,004	4.08
1940	123	307	1,108	3.60
1941	135	339	1,275	3.76
1942	149	376	1,794	4.77
1943	157	391	2,620	6.70
1944	210	489	2,976	6.08
1945	233	538	3,755	6.97
1946	255	566	3,484	6.15
1947	259	573	3,542	6.18
1948	283	616	4,627	7.51
Total	283	616	27,205	

Analysis of Actuators to Date

	Actuators	Per cent
Brake riggings.....	8,908	32.71
Cast steel side frames.....	11	0.05
Truck parts.....	689	2.54
Safety truck chains.....	391	1.44
Steam heat connections.....	1,621	5.96
Generator belts.....	1,587	5.84
Miscellaneous.....	7,813	28.72
Unknown.....	6,185	22.74
Total.....	27,205	100

Expenditures to date covering the installation of these devices amount to approximately \$1,265 per equipped track. Present-day costs bring this figure up to approximately \$2,500 per track at the end of 1948.

Figure 1 shows a typical dragging equipment installation. Originally, this road mounted detector arms on side of large wood blocks secured to top of ties. With this design, single arms were employed inside and outside each rail. Later an improved type shown in Fig. 1 came into use. It provides full coverage between rails and mounts arms directly on side of ties. In recent years, this road has also been experimenting with a self-restoring type of detector on a limited basis. Its performance has been highly efficient to date, and trial installations are being expanded.

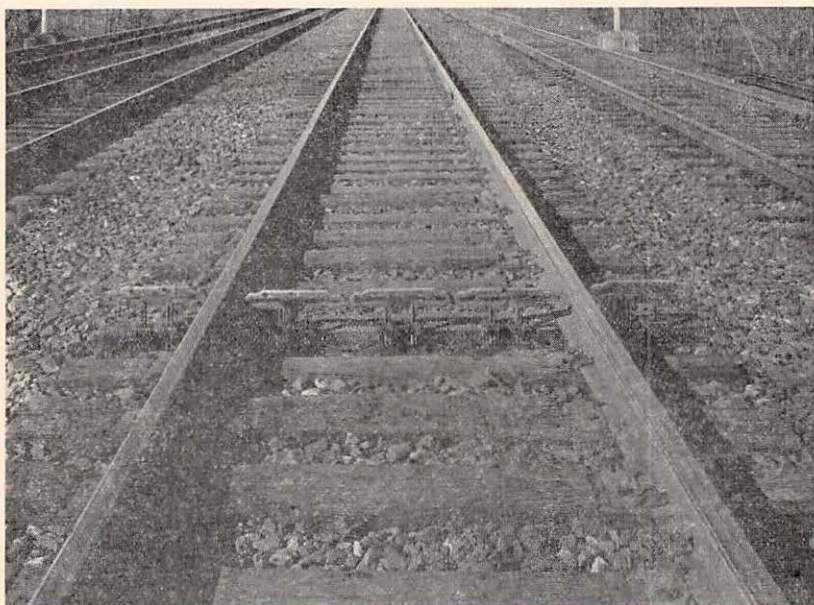


Fig. 1.

While some accidents still occur at points where detectors are now normally provided it is definite that a large number of accidents in or adjacent to interlockings have been prevented by the functioning of the dragging equipment detectors. The resulting savings cannot be estimated but are a major item.

Action Recommended

Acceptance as information.

FREIGHT TRAIN TIME SAVED WHERE TRAINS ARE
OPERATED BY SIGNAL INDICATION

The Committee submits a consolidation of reports on 41 installations previously reported in the Proceedings*:

Rail- road	Miles Road	Track	Avg. frt. trains per day	Max. trains per day	Avg. frt. train time saved per trip, minutes	Per cent time saved	Minutes saved per frt. train mile
1	12.5	25.0	14.0	34	9.0	20.0	0.72
2	35.8	43.8	10.0	42	41.0	26.0	1.14
3	43.0	43.0	12.0	20	40.0	22.0	0.93
4	17.0	17.0	36.0	46	20.0	25.0	1.18
5	6.1	6.1	10.0	30	12.0	28.6	1.97
6	5.0	5.0	45.0	47	10.0	15.4	2.00
7	95.5	105.1	11.0	34	46.0	20.0	0.48
8	25.3	27.8	11.6	45	19.4	17.2	0.77
9	31.4	31.4	24.0	30	47.0	34.9	1.50
10	5.3	5.3	16.0	22	22.5	50.0	4.24
11	42.0	42.0	24.0	60	59.4	32.2	1.41
12	49.9	49.9	23.0	36	56.4	15.2	1.13
13	40.0	44.2	19.3	31	72.0	26.0	1.76
14	14.8	14.8	29.5	43	9.1	23.7	0.61
15	30.2	30.2	11.0	33	49.8	47.0	1.65
16	19.8	24.0	16.5	28	12.2	20.8	0.62
17	39.7	42.0	18.7	34	68.5	39.8	1.73
18	31.8	63.7	31.0	50	60.0	20.0	1.89
19	37.0	37.0	11.2	26	10.0	11.6	0.27
20	28.0	35.0	28.6	36	22.1	29.4	0.79
21	12.0	12.0	8.4	28	12.6	28.8	1.05
22	60.7	60.7	7.2	17	29.1	15.5	0.48
23	175.0	175.0	12.0	50	175.0	26.0	1.00
24	39.9	39.9	12.0	28	32.0	30.0	0.80
25	117.8	127.8	45.0	50	138.0	31.0	1.17
26	47.0	62.0	54.0	65	45.0	25.0	0.96
27	59.7	69.7	30.0	48	59.0	26.0	0.99
28	64.6	64.6	26.0	28	60.0	32.0	0.93

* Railroads 1 to 19, incl.—A.A.R. Signal Section 1936 Proceedings, Vol. XXXIV, p. 60.

Railroads 20 and 21 —A.A.R. Signal Section 1940 Proceedings, Vol. XXXVIII, pp. 11 and 12.

Railroad 22 —A.A.R. Signal Section 1941 Proceedings, Vol. XXXIX, p. 12.

Railroads 23 to 28, incl.—A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, p. 63.

Railroads 29 to 41, incl.—A.A.R. Signal Section 1947 Proceedings, Vol. XLV, p. 55.

Rail-road	Miles		Avg. frt. trains per day	Max. trains per day	Avg. frt. train time saved per trip, minutes	Per cent time saved	Minutes saved per frt. train mile
	Road	Track					
29	53.0	53.0	16.3	27	88.0	33.3	1.66
30	47.0	62.0	49.1	65	53.0	15.8	1.13
31	121.4	122.7	37.0	43	74.3	25.2	0.61
32	84.8	95.3	23.3	33	48.5	18.5	0.57
33	33.7	33.7	18.0	24	14.5	13.9	0.43
34	68.0	72.0	24.7	48	33.0	15.7	0.49
35	42.0	45.0	27.6	42	22.0	18.5	0.52
36	43.0	45.0	39.7	58	60.0	33.1	1.40
37	111.0	115.0	30.0	50	105.0	26.4	0.95
38	92.0	92.0	20.0	30	57.0	25.6	0.62
39	127.2	131.9	20.0	40	70.0	19.9	0.55
40	86.6	86.6	19.3	30	52.0	22.7	0.60
41	52.7	57.7	22.0	25	25.0	10.0	0.47
	2,150.1		944.0		1,939.4		

The 41 installations cover a total of 2,150 road miles, with an average of 23 freight trains per day, and an average saving of 0.90 minute per road mile or 1.08 minutes per freight train mile per installation.

The freight train time saving per mile or per installation will vary due to local conditions on each project. It will be higher with greater train densities than with a lower number of trains per day.

Where a railroad is estimating the freight train time saving for a future project, the information in this report may be of assistance in arriving at an estimated freight train time saving per mile.

Action Recommended

Acceptance as information.

OPERATING ADVANTAGES OF MANUALLY OPERATED INTER-
LOCKING ON CHICAGO & EASTERN ILLINOIS R.R. AT
CROSSING WITH WABASH R.R. AND PEORIA &
EASTERN RY. (NEW YORK CENTRAL R.R.)
AT DANVILLE, ILL.*

The Chicago & Eastern Illinois R.R. installed, in 1947, a new electric interlocking at Danville, Ill., at a complicated crossing with the Wabash R.R. and Peoria & Eastern Ry. The track layout included three tracks of the Chicago & Eastern Illinois crossing two tracks of the Wabash, and two tracks of the Wabash and one track of the Chicago & Eastern Illinois crossing a single track of the Peoria & Eastern, forming a triangle of tracks between the crossings, which are approximately 1,250 feet apart. The track and signal layout of the interlocking are shown in Fig. 1.

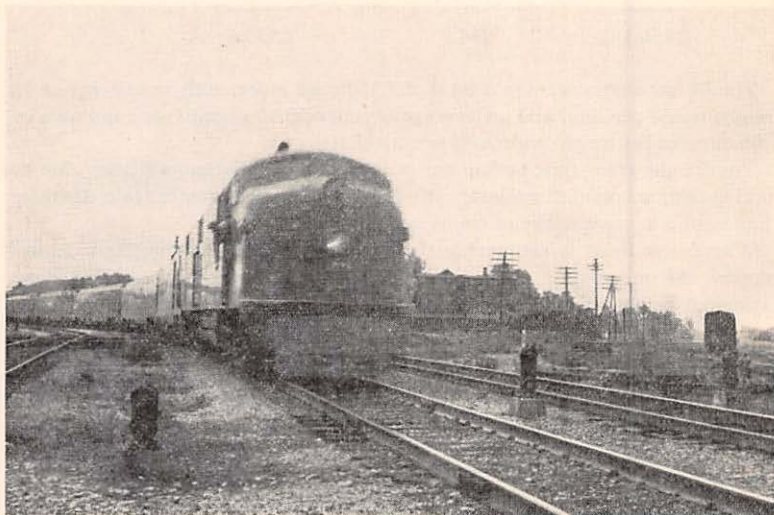


Fig. 1.

The location where the Chicago & Eastern Illinois crosses the Wabash is known as North Yard; the crossing between the Chicago & Eastern Illinois main line and the Peoria & Eastern is known as Cory; and the location where the Chicago & Eastern Illinois and Wabash cross the Peoria & Eastern is designated Danville Junction. The North Yard crossing is on a 4-degree curve on the Chicago & Eastern Illinois and 2-degree curve on the Wabash, while the other main line crossings are tangent. (See Fig. 2.)

* *Railway Age*, February 21, 1948, pp. 42-44.

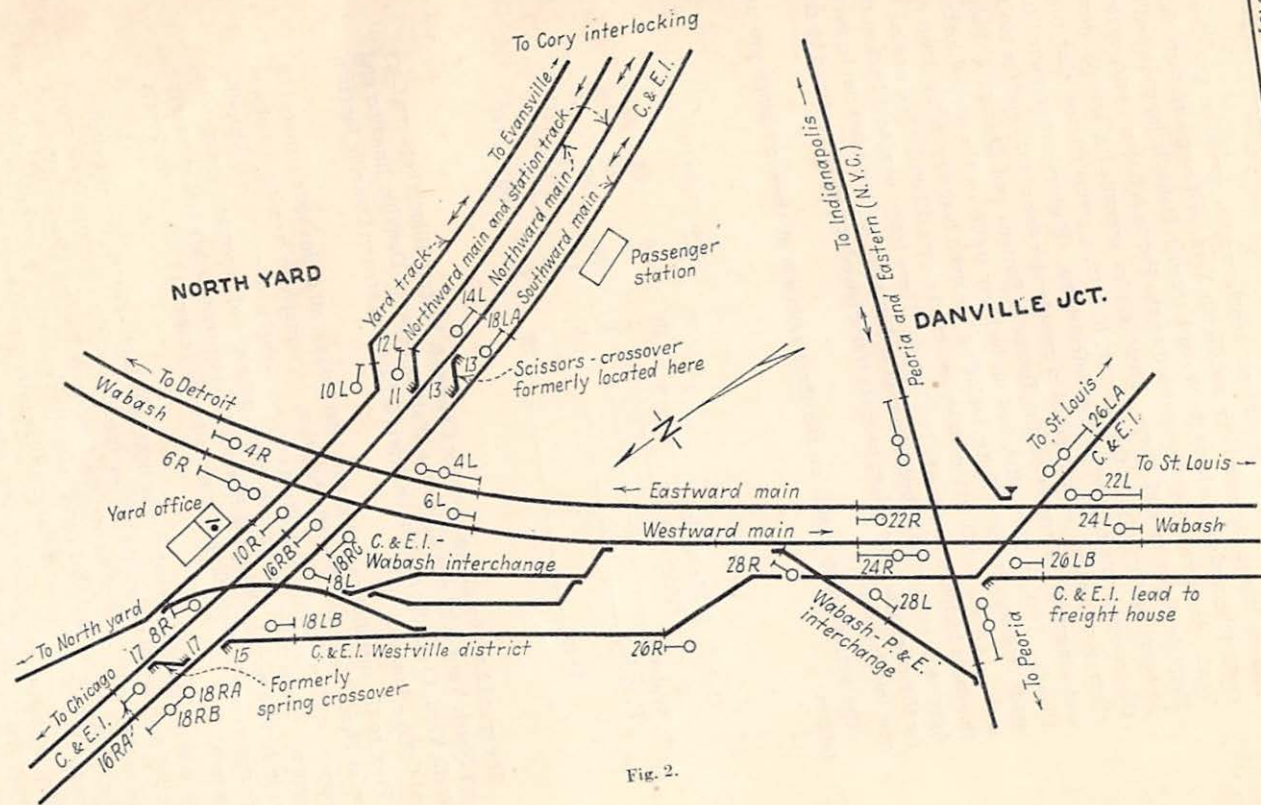


Fig. 2.

Northward there is an 0.55 per cent ascending grade on the Chicago & Eastern Illinois through Cory and North Yard, and eastward there is an 0.6 per cent ascending grade on the Wabash through Danville Junction and North Yard. An ascending grade eastward on the Peoria & Eastern extends through Danville Junction and Cory. These grades presented a serious operating problem, particularly on the Wabash, in getting trains started after stops at the crossings formerly without an interlocking. Pushers were required to get them started again. This resulted in considerable loss of time and the blocking and congestion of tracks on the Peoria & Eastern and Chicago & Eastern Illinois. This, in turn, often tied up highway traffic on the several highway grade crossings in the vicinity, including the main highway in the downtown area. As many as 100 automobiles and trucks were delayed while waiting for this main highway crossing to be cleared. These trains now hold back at the Approach signal until a Proceed aspect is displayed, so that a run can be made for the crossings. The delays to street traffic have been greatly reduced by the new interlocking.

The average daily traffic on the three railroads at these crossings was as follows:

	Pass.	Average Trains Daily		Total
		Frt.	Sw.	
C. & E. I. Main Line.....	18	10	25	53
Branch Line.....	2	4	0	6
Wabash.....	4	26	20	50
P. & E.....	4	12	15	31
Total.....	28	52	60	140

The speed limit for all trains on the Chicago & Eastern Illinois between Cory and North Yard is 20 m.p.h.; on the Wabash between Danville Junction and North Yard, 15 m.p.h.; and on the Peoria & Eastern between Danville Junction and Cory, 20 m.p.h.

Prior to the installation of the new interlocking, all trains were required to stop at North Yard and Danville Junction. A semaphore crossing signal was in service at North Yard and a tilting crossbar signal was in service at Danville Junction. Train orders, automatic block signals, and automatic train stops were in service on the Chicago & Eastern Illinois; train orders and automatic block signals on the Wabash; and train orders and manual block on the Peoria & Eastern.

The new interlocking includes color light signals and electric power switches controlled from an all-relay interlocking machine of the miniature lever type located in the North Yard office near the Chicago & Eastern Illinois—Wabash crossing. The project included signal indication operation in both directions on three tracks of the Chicago & Eastern Illinois through the station area.

Besides increasing the safety of train operation on the three railroads at these crossings, the new interlocking eliminated train stops and train delays, increased the efficiency of train operation, and eliminated delays to highway traffic at street crossings.

Sept. 1949]

Com. I—Economics of Ry. Signaling

The train time saved daily is estimated as follows:

Chicago & Eastern Illinois Time Saving Daily

18 passenger trains	@ 3 minutes	54 minutes
35 freight trains	@ 10 minutes	350 minutes
Total.....		404 minutes

Wabash Time Saving Daily

2 E.B. passenger trains	@ 10 minutes	20 minutes
2 W.B. passenger trains	@ 8 minutes	16 minutes
13 E.B. freight trains	@ 20 minutes	260 minutes
13 W.B. freight trains	@ 10 minutes	130 minutes
20 switching movements	@ 10 minutes	200 minutes
Total.....		626 minutes

Peoria & Eastern Time Saving Daily

4 passenger trains	@ 3 minutes	12 minutes
27 freight trains	@ 10 minutes	270 minutes
Total.....		282 minutes

Grand total all railroads....1,312 minutes, or 21.9 hours daily

Total freight train time saving.....20.2 hours daily

This interlocking installation is estimated to save 55,000 train stops annually, in addition to the time lost.

The annual saving, due to increased safety, elimination of pusher service due to stalled trains, break-in-two's and reduced maintenance and operation of the previous signal protection at North Yard and Danville Junction, is estimated at \$11,500. The annual saving due to freight train time saved is estimated at \$73,730. The annual saving due to train stops eliminated is estimated at \$27,500, or a total annual saving of \$112,730.

The increased annual cost of maintenance, operation, and depreciation is estimated at \$5,000.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$54,647
(b) Operating Expenses.....	10,065
(c) Total.....	\$64,712
2. Gross Saving per Annum.....	\$112,730
3. Increased Annual Operating Expenses.....	5,000
4. Net Reduction in Annual Operating Expenses.....	\$107,730
5. Deduction for Interest Charges @ 5% (of 1-a).....	2,732
6. Net Saving per Annum.....	\$104,998
7. Annual Return over 5% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	192%
(b) On Total Cost ($6 \div 1-c$).....	162%

Action Recommended

Acceptance as information.

ADVANTAGES OF ROCK SLIDE DETECTOR FENCES

Three Western railroads report installation of approximately 260,000 feet of rock slide protection fence varying from 20 to 3,200 feet in length per installation and from one to three tier in height, as well as overhead type near tunnel portals or vertical cliff protection.

All installations of the various types of protection substantially follow A.A.R. Sig. Sec. 1505B and 1506A with certain revisions due to local conditions encountered, and the installation costs vary from \$1.25 to \$9.50 per foot, depending upon territory involved.

The reporting railroads operate in mountainous territories, through canyons and large cuts where the right-of-way is subject to rock slides and where, due to heavy curvatures the view is often restricted, which increases the potential hazard of accident should a slide obstruct the tracks.

The circuits are so arranged that the signals controlled by the slide protection indicate "Stop" or "Stop and Proceed" should a fence be struck, destroyed or actuated by a slide; that is, if the fence protection is within the block of a stop signal, the indication would be "Stop" whereas if it were within the limits of a "Stop and Proceed" signal, it would be "Stop and Proceed."

One railroad reports that a stick circuit is used to avoid possibility of the fence-operated relay being tipped over by the slide and reclosing the circuit. The other two do not use this system—they locate the relay in what is considered "outside of slide area."

In centralized traffic control territory, two roads report that separate indications are brought into the control machine showing that the fence has been actuated, which often results in the condition being corrected and repaired prior to arrival of a train.

During the critical seasons, *i.e.*, rainy or thawing periods, the slide fences are operated on an average of 30 times per month on each of the reporting roads, resulting in stopping an average of 35 trains per road per month. Many reports of slides actuating the protecting devices refer to "500# rock," "two tons of rock;" while others state "fifty pound rock," "rocks," etc., so that no actual data are available at present as to which slides would have resulted in derailments had no warning signals been provided, but there have been no derailments due to striking slides in the territories protected since the installation of the protective devices.

Action Recommended

Acceptance as information.

ECONOMICS OF USE OF YARD TRACK INDICATORS

At the 1948 Annual Meeting*, the Committee presented a report on this subject, covering one installation at one end of a 125-mile centralized traffic control installation, involving 12 freight train movements daily. Data is now submitted on three additional installations on another railroad involving 15, 11 and 7 freight train movements daily at yards in two-track automatic block signal territory, as follows:

*Case 1**Station A, East End Yard, Westward Train.*

Fifteen freight trains receive yard track indications daily with an average time saving of 5 minutes per train, or an annual time saving of 456.3 train hours.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$1,600
(b) Operating Expenses.....	—
(c) Total.....	<u>\$1,600</u>
2. Gross Saving per Annum.....	\$10,107
3. Increased Annual Operating Expenses.....	20
4. Net Reduction in Annual Operating Expenses.....	\$10,087
5. Deduction for Interest Charges @ 6% (of 1-a).....	96
6. Net Saving per Annum.....	<u>\$ 9,991</u>
7. Annual Return over 6% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	624%

*Case 2**Station A, West End Yard, Eastward Train.*

Eleven freight trains receive yard track indications daily with an average time saving of 5 minutes per train, or an annual time saving of 334.6 train hours.

* A.A.R. Signal Section 1947 Proceedings, Vol. XLV, p. 56.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$1,400
(b) Operating Expenses.....	—
(c) Total.....	\$1,400
2. Gross Saving per Annum.....	\$7,411
3. Increased Annual Operating Expenses.....	20
4. Net Reduction in Annual Operating Expenses.....	\$7,391
5. Deduction for Interest Charges @ 6% (of 1-a).....	84
6. Net Saving per Annum.....	\$7,307
7. Annual Return over 6% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	522%

*Case 3**Station B, West End Yard, Eastward Train.*

Seven freight trains receive yard track indications daily with an average time saving of 5 minutes per train, or an annual time saving of 212.9 train hours.

Economic Statement

1. Cost of Installation:	
(a) Capital Investment.....	\$1,300
(b) Operating Expenses.....	—
(c) Total.....	\$1,300
2. Gross Saving per Annum.....	\$4,716
3. Increased Annual Operating Expenses.....	20
4. Net Reduction in Annual Operating Expenses.....	\$4,696
5. Deduction for Interest Charges @ 6% (of 1-a).....	78
6. Net Saving per Annum.....	\$4,618
7. Annual Return over 6% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	355%

Action Recommended

Acceptance as information.

ECONOMICS OF "OFF TRACK" EQUIPMENT*

A survey of a number of Western railroads developed that substantial time savings, decreased hazard of motor car accidents, flexibility of transporting men and materials, are distinct advantages derived from use of "Off Track" equipment, particularly in cases of emergencies.

The reports submitted covered 37 construction gangs varying from 8 to 30 men each, the average being 12 men per gang, and indicated the average time saving per man was one hour per day. Under present wage scales, the average wage was \$1.28 per hour. The reports also used 300 days per year as average time "Off Track" equipment was used, resulting in the following:

Average man hours saved per gang per day.....	12
Average wage per hour.....	\$1.28
Average wage saving per gang per day.....	\$15.36
Average wage saving per gang per annum (300 days).....	\$4,608.00

Annual operating expense is based on average consumption of gasoline, oil, insurance, licenses, repairs and depreciation (25 per cent of purchase price).

The gangs involved were engaged in construction of centralized traffic control, automatic cab signaling, respacing and modernizing automatic block signal systems, retarder yard installations and rail relay programs.

Economic Statement

1. Average Cost per Truck:	
(a) Capital Investment.....	\$2,400
(b) Operating Expenses.....	—
(c) Total.....	\$2,400
2. Gross Saving per Annum.....	\$4,608
3. Increased Annual Operating Expenses.....	1,900
4. Net Reduction in Annual Operating Expenses.....	\$2,708
5. Deduction for Interest Charges @ 6% (of 1-a).....	144
6. Net Saving per Annum.....	\$2,564
7. Annual Return over 6% Interest:	
(a) On Capital Investment ($6 \div 1-a$).....	107%

Action Recommended

Acceptance as information.

* Previous report appears in A.A.R. Signal Section 1942 Proceedings, Vol. XL, pp. 7-A and 274-A.

COMMITTEE II—INTERLOCKING

Personnel

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J. P. Hopton*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Collaborate with A.R.E.A. Committee 5 on switch, frog and crossing layout plans, in order to make layouts as universal as possible for the application of signals and interlocking, including location of insulated rail joints in turnouts, crossovers and crossings.
4. Prepare typical plans for interlocked and spring switch layouts.
5. Investigate and report on maximum permissible speed, trailing through closed point of spring switch with respect to:
 - (a) Buffer limitations on non-facing point lock types.
 - (b) Buffer and mechanism limitations on mechanical facing point lock types.
6. Investigate and prepare recommendations to A.R.E.A. Committee 5 for inclusion of application of roller bearings to interlocked and spring switch layout plans, collaborating in accordance with Assignment 3.
7. Specification for car retarder control machine.
8. Specification for electric car retarder mechanism.
9. Specification for electro-pneumatic car retarder mechanism.
10. Specification for electric switch operating mechanisms for car retarder yards.
11. Specification for electro-pneumatic switch operating mechanisms for car retarder yards.
12. Specification for electric skate operating mechanism.
13. Specification for electro-pneumatic skate operating mechanism.

* Consulting Member.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Specification 147-40, Manual Part 27.
Revision of Specification 76-45, Manual Part 85.
Revision of Specification 128-44, Manual Part 129.
4. Typical plans for interlocked and spring switch layouts.
5. Maximum permissible speed, trailing through closed point of spring switch with respect to (a) buffer limitations on non-facing point lock types and (b) buffer and mechanism limitations on mechanical facing point lock types.
7. Specification 245-49.
Specification 241-49.
8. Specification 246-49.
9. Specification 242-49.
10. Specification 247-49.
11. Specification 243-49.
12. Specification 248-49.
13. Specification 244-49.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

- A.I.E.E.—American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.
A.R.E.A.—American Railway Engineering Association, 59 E. Van Buren St., Chicago 5, Ill.
A.S.M.E.—American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

Disposition of 1948 Letter Ballot Subject

The following subject presented by this Committee at the 1948 Annual Meeting was submitted to letter ballot and officially approved:

Requisites for Yard Track Indicators for Indicating to a Train the Track to be Entered—Now in Manual Part 46.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

(Revision of A.A.R. Signal Section Specification 147-40)
A.A.R. SIGNAL SECTION SPECIFICATION 147-49.

CAR RETARDER SYSTEM

General Provisions

1. Details of work.

(a) Details of work include the following:

1. Buildings.
2. Power supply.
3. Distributing system:
 - (a) Aerial.
 - (b) Surface.
 - (c) Underground.
 - (d) Submarine.
 - (e) Main air pipe line.
4. Control machine.
5. Car retarder and fittings.
6. Switch operating mechanism and fittings.
7. Skate operating mechanism and fittings.
8. Signal system:
 - (a) Hump.
 - (b) Repeater.
 - (c) Trimmer.
 - (d) Switch.
 - (e) Cab.
 - (f) Audible signals.
 - (g)
9. Communication system:
 - (a) Telephone.
 - (b) Loud speaker.
 - (c) Teletype.
 - (d) Pneumatic tubes.
 - (e) Train communication system.
 - (f)
10. Foundations.
11. Wires and cables.
12. Conduits and supports.
13. Instrument and battery housings.
14. Insulation.
15. Bonding.
16. Painting.
17. Flood and other lighting.
18.
19.

(b) Car retarder system shall be designed to handle cars of lb. maximum gross weight for a cut-off speed of miles per hour and be capable of retarding the speed to not more than miles per hour at the junction

1. *Details of work.*—Continued.

switch, and further retarding the speed to a minimum of miles per hour while leaving the last retarder and be capable of maintaining this cut-off speed while humping.

2. *Unit specifications, drawings, requisites and requirements.*

(a) Unit specifications, drawings, requisites and requirements referred to in the body of this specification form an essential part hereof.

3. *Drawings.*

(a) Purchaser's drawings form an essential part of this specification and should contain the following information:

1. Station maps drawn to scale showing track arrangement, profile and surroundings; pole line or other supports for aerial lines; approximate number of poles per mile, approximate average distance of nearest pole from each terminal location to which line connections are required; location of conduits, number, kind and size of ducts, and location and type of manholes; notations showing the sections of rail and drilling of rail joints. Drawing, dated

2. Track plan of hump end of classification yard, present or proposed, or both, drawn to scale of not less than 1 in. equaling 50 ft. showing the length of the turnouts and switches to be power-operated; electric or pneumatic power mains, conduit or underground cable runs; power house; location of present battery and transformer housings and wire terminal locations; type and limits of track circuits and such other information as is desirable. Where any of the above items are now installed the plan should so indicate. Drawing, dated

3. Control towers. Drawings, dated

4. Power house. Drawing, dated

5. Other standards and drawings. Drawing, dated

(b) Contractor's drawings.

1. Contractor shall furnish with his proposal, drawings or references for the apparatus he proposes to furnish, which are not covered by the drawings furnished by the Purchaser.

2. After the award of contract and before work is begun, the Contractor shall furnish for the approval of the Purchaser, the following drawings as scheduled by the Purchaser (*R-3-b-2):

(a) Track plan showing retarders, switches, signals, skate mechanisms, relays, transformers, and batteries and their locations, within days.

(b) Detail circuit plans, within days.

* Alternate requisites section.

3. *Drawings.*—Continued.

- (c) Instrument case wiring plans, within days.
 - (d) Cable diagrams, within days.
 - (e) Pole line diagrams, within days.
 - (f) Location of the main air line, air strainers, including auxiliary reservoirs, valves, alcohol feeders, insulated unions, branch connections and expansion joints, within days.
3. After receipt of the drawings, the Purchaser will indicate any corrections that may be necessary, or signify his approval, within days.
4. Contractor shall be responsible for the correctness of all drawings furnished by him, although the drawings may have been approved by the Purchaser.
5. Any work done by the Contractor prior to the approval of the Contractor's drawings will be done at the Contractor's risk, unless previously authorized in writing by an accredited representative of the Purchaser.
6. Plans showing typical circuits for the control of car retarders, signals, indicators and other devices. Drawing, dated
7. After contract is awarded each party shall furnish the other, as required, prints of approved drawings.
8. No change shall be made in any approved drawing without the written consent of the Purchaser.
9. After completion of contract, the Contractor shall designate on station map, location of underground cable, main air line, air strainers, auxiliary reservoirs, valves, branch connections and expansion joints.
10. After completion of contract, the Contractor shall furnish the Purchaser corrected tracings of drawings furnished by him.
11. Track diagrams shall be furnished in place in control towers by Contractor. *R-3-b-11.

4. *Furnished by the Purchaser.*

- (a) Purchaser will furnish, as indicated in sections 4-b,c and d, material or labor, or both, on the following items:
- 1. Ties for support of apparatus.
 - 2. Move ties as may be necessary.
 - 3. Switches of required throw.
 - 4. Move switch and tie rods as may be necessary.
 - 5. Rail welding where required.
 - 6. Track bonding.
 - 7. Insulated rail joints.
 - 8. Bridge insulations.
 - 9. Switch-rod insulations.

* Alternate requisites section.

4. *Furnished by the Purchaser.*—Continued.

10. Tie-rod insulations.
11. Gage-plate insulations.
12. Gage plates.
13. Rail braces.
14. Concrete material:
 - (a) Cement.
 - (b) Sand.
 - (c) Stone.
 - (d) Water.
 - (e) Transit mixed.
15. Precast foundations.
16. Grading and drainage.
17. Excavation of solid rock.
18. Poles, guy wires, anchors and bracing for aerial lines.
19. Cross-arms, pins, insulators and hardware.
20. Line wire.
21. Battery housings.
22. Cables:
 - (a) Aerial.
 - (b) Underground.
 - (c) Submarine.
 - (d)
 - (e)
23. Conduit:
 - (a) Main.
 - (b) Branch.
 - (c)
 - (d)
24. Manholes.
25. Sand, clay or loam for cable trench, including protection plank.
26. Make alterations of any part of existing structures or apparatus.
27. Unload and properly house material that arrives on the ground before the Contractor's force; this work to be done under the supervision of the Contractor's representative.
28. Distribute material.
29. Obtain permits from Federal, State and Municipal authorities where required.
30. Buildings.
31. Tools, fixtures for building and supplies required for maintenance of system.
32. Prior to installation, furnish stakes establishing grade of track where required.
33. Communication systems.
34. Number plates.
35. Flood lighting.
36.
37.

4. *Furnished by the Purchaser.*—Continued.

- (b) Material only on items
- (c) Labor only on items
- (d) Material and labor on items
- (e) Purchaser will furnish the items as indicated in sections 4-b, c and d, subject to inspection of the Contractor, who shall state any objections thereto before starting his part of the work. After rectification by the Purchaser of any defects reported, the Contractor shall assume full responsibility for the proper functioning of the installation. The intent of this section is to bar any claim by the Contractor that the work done by the Purchaser has not been performed in such manner as to enable him to fulfill all the provisions of the contract.

5. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

(b) Where blanks have not been filled, or where an option is permitted and no preference stated, the Contractor's recommended practice shall be followed.

6. *Shipment of material.*

(a) Material shall be shipped to, care of, marked for Material shipped from Contractor's factory at shall be shipped via and thence via to destination.

7. *Transportation.*

(a) Purchaser will furnish transportation for men, necessary for the installation, over the following lines (*R-7-a):

- 1.
- 2.

(b) Purchaser will furnish transportation for tools and material, necessary for the installation, over the following lines (*R-7-b):

- 1.
- 2.

(c) Purchaser will furnish work train service for distribution of material. *R-7-c.

(d) Purchaser will furnish work train service for erection of apparatus. *R-7-d.

(e) Purchaser will furnish derrick service for erection of apparatus. *R-7-e.

* Alternate requisites section.

8. Inspection of installation.

(a) Contractor shall advise the Purchaser days in advance of the time installation will be completed and ready for final inspection. Purchaser will make inspection and tests within days after completion of the work.

9. Tests.

(a) Contractor shall make such tests as may be necessary to demonstrate, to the satisfaction of the Purchaser, that the apparatus, as installed, is in accordance with the requirements of the specifications and contract. These tests, unless otherwise specified, shall include the tests shown in section 9-b and shall be conducted in accordance with A.A.R. Signal Section instructions for testing. Contractor shall provide such instruments and apparatus as may be necessary for making tests. Instruments and apparatus shall remain the property of the Contractor.

(b) The following tests shall be made in accordance with A.A.R. Signal Section instructions for testing, unless otherwise specified by the Purchaser:

1. General.

(a) Tests to determine that all circuits conform to approved circuit plans by individually electrically checking each contact selection.

(b) Test of all electrically operated devices to determine that electrical operating characteristics are in accordance with Manufacturer's specifications.

2. Insulation.

(a) Test of insulation resistance for each complete circuit except battery and common connections to determine that resistance is not less than 1 megohm between conductors and to ground.

3. Car retarders.

(a) Test of retarders to determine that they follow the position of the control units in the control tower and that adjustments are in accordance with Manufacturer's specification.

(b) Test of motor brake to determine that it is properly adjusted.

(c) Test car retarders to determine proper operation at prescribed minimum air pressure or operating voltage.

4. Switch mechanisms.

(a) Test of switch point indicator circuits to determine that the switch will not indicate normal or reversed position when switch points are open $\frac{1}{4}$ in. or more.

(b) Test to determine that electric switch motor is snubbing properly.

(c) Test to determine that electric switch clutch is properly adjusted.

9. Tests.—Continued.

(d) Test to determine that trailable feature is operating properly.

(e) Test of switches to determine proper operation at prescribed minimum air pressure or operating voltage and that the time from the throwing of the controlling switch lever to the completion of the switch movement shall, under normal operating conditions, occur in not more than 1.2 seconds. *R-9-b-4-e.

5. Skate mechanisms.

(a) Test to determine that mechanism properly places skate on rail and will remove skate from rail.

(b) Test to determine that electric skate mechanism clutch is properly adjusted.

6. Control machine.

(a) Test to determine that all positions of levers correspond with proper positions of devices on the ground.

(b) Test of control contacts to determine that adjustments conform to approved plan.

7. Track circuit.

(a) Test to determine that track circuits have been installed and adjusted in accordance with approved plans and specifications.

(b) Test to determine that track circuit shunting sensitivity is not less than 0.06 ohm.

8. Voltage.

(a) Tests to determine that voltage for all apparatus is in accordance with Manufacturer's specifications and that voltage applied to lamps is in accordance with specifications furnished by the Purchaser.

9. Air line.

(a) Tests to determine that air distribution system is such that leakage in any section of the system will not exceed 1 lb. in one minute from normal pressure with all apparatus connected and at rest.

10. Placing in service.

(a) After receipt of written authority from the Purchaser, the Contractor shall place the installation in service under supervision of the Purchaser, and shall leave competent men on duty for days thereafter. *R-10-a.

(b) Signal aspects shall be displayed or changed only as authorized by the Purchaser.

* Alternate requisites section.

11. *Completion.*

(a) When installation is completed, apparatus and surface of the ground which has been affected by the installation, shall be left in a neat and clean condition and all temporary structures removed.

12. *Clearances.*

(a) Clearances shall conform to clearance diagram recommended by the A.A.R. *R-12-a.

*Detail Provisions*13. *Building foundations.*

(a) Foundation shall be in accordance with Specification _____, dated _____, and Drawing _____, dated _____.

14. *Control tower.*

(a) Building shall be in accordance with Specification _____, dated _____, and Drawing _____, dated _____.

15. *Power house.*

(a) Building shall be in accordance with Specification _____, dated _____, and Drawing _____, dated _____.

16. *Flood and other lighting.*

(a) Lighting shall be in accordance with Specification _____, dated _____, and Drawing _____, dated _____.

(b) Wiring, fixtures, accessories and installation for electric lighting shall be in accordance with rules of the National Board of Fire Underwriters and requirements of local authorities.

17. *Power supply.*

(a) Purchaser will furnish _____ volts d.c. or _____ volts a.c., _____ cycles, _____ phase at points as shown on Drawing _____, dated _____.

18. *Power plant.*

(a) Power plant shall consist of _____.

(b) _____ shall be furnished by _____ and installed by _____.

(c) _____ shall be furnished by _____ and installed by _____.

* Alternate requisites section.

19. *Auxiliary power plant.*

- (a) Auxiliary power plant when required shall consist of
(b) shall be furnished by and installed by
(c) shall be furnished by and installed by

20. *Air compressors, governors and strainers.*

- (a) Air compressors, { one-stage
 compound }, with a capacity of cu. ft. piston displacement free air per minute, and designed for air pressure of lbs., manufactured by, shall be furnished and installed in place on a foundation by Contractor, and constructed in accordance with the specifications which shall be attached to the Contractor's bid. *R-20-a.
(b) Automatic governors shall be provided by and shall be arranged to cut in the compressor at lb. and cut out at lb. pressure. *R-20-b.
(c) An air strainer approved by the Purchaser, shall be installed in each air intake pipe.
(d) When air compressors are furnished in duplicate, interchange control panels shall be furnished for operating each compressor from either of the governors. *R-20-d.
(e) Air compressors shall be direct-connected and motor-driven and shall be mounted on a cast-iron base. Motor shall be in accordance with A.I.E.E. Standards. *R-20-e.

21. *Generator.*

- (a) Alternating current generator shall be of kv-a. capacity at frequency, volts, phase, and shall be in accordance with A.I.E.E. Standards.
(b) Direct current generator shall be of k.w. capacity at volts, and shall be in accordance with A.I.E.E. Standards.

22. *Motor.*

- (a) Motor shall be h.p. capacity at frequency, volts, phase a.c.; or volts d.c., and shall be in accordance with A.I.E.E. Standards.

23. *Motor-generator.*

- (a) Motor-generator shall be direct-connected, mounted on a cast-iron or arc-welded steel fabricated sub-base. *R-23-a.

* Alternate requisites section.

24. *Transformers.*

(a) Oil-cooled transformer shall be in accordance with Specification 84, Manual Part 165.

(b) Air-cooled transformer shall be in accordance with Specification 83, Manual Part 164.

(c)

25. *Rectifiers.*

(a) Rectifiers shall be of type.

(b) Rectifiers shall be in accordance with the following specifications, where applicable:

1. Copper-Oxide Rectifier—Specification 166, Manual Part 139.

2. Selenium Rectifier—Specification 229, Manual Part 243.

3. Tantalum Rectifier—Specification 189, Manual Part 47.

(c) Track circuit rectifier characteristics.

1. A.C. volts, cycles

2. D.C. volts max., min., amperes max., min., for:

(a) Operating track circuits direct.

(b) Charging cells, type storage battery.

(c) Use in multiple with cells, type primary battery.

(d) Line circuit rectifier characteristics.

1. A.C. volts, cycles

2. D.C. volts max., min., amperes max., min., for:

(a) Operating line circuits direct.

(b) Charging cells, type storage battery.

(c) Use in multiple with cells, type primary battery.

(e) Signal operating rectifier characteristics.

1. A.C. volts, cycles

2. D.C. volts max., min., amperes max., min., for:

(a) Operating signals direct.

(b) Charging cells, type storage battery.

(c) Use in multiple with cells, type primary battery.

(f) rectifier characteristics.

1. A.C. volts, cycles

2. D.C. volts max., min., amperes max., min., for:

(a)

25. *Rectifiers.*—Continued.

- (b) Charging cells, type
storage battery.
(c) Use in multiple with cells, type
..... primary battery.

26. *Batteries.*

(a) Batteries shall be in accordance with the following specifications and drawings:

1. Nickel, Iron, Alkaline Storage Battery—Specification 49, Manual Part 15.

2. Lead Acid Stationary Storage Battery (Plates of Pure Lead)—Specification 58, Manual Part 19.

3. Lead Acid Stationary Storage Battery (Plates of Alloy Composition)—Specification 158, Manual Part 117.

4. Lead Acid Stationary Storage Battery (Plates of Composite Structure)—Specification 53, Manual Part 18.

5. Specification for Electrolyte, Manual Part 13.

6. Type "A" Copper-Oxide Caustic Soda Primary Cell—Specification 87, Manual Part 6.

7. Type "B" Copper-Oxide Caustic Soda Primary Cell—Specification 171, Manual Part 4.

8. Battery Jar (Primary)—Specification 113, Manual Part 9.

9. Air Depolarized Carbon Caustic Soda Primary Cell—Specification 172, Manual Part 16.

10. Battery Jar (Storage)—Specification, dated

11. Round Jars and Cover—Drawing 1053.

12. Rectangular Jars and Cover—Drawing 1418 or 1419.

(b) Jars for caustic soda type of battery shall conform to Drawing, dated

(c) Main operating batteries shall consist of sets
..... cells of type ampere-hour capacity.

(d) Local operating batteries shall consist of:

1. sets cells of type
..... ampere-hour capacity.

2. sets cells of type
..... ampere-hour capacity.

(e) Track batteries shall be of cells of
type ampere-hour capacity.

(f) Line batteries shall be of cells of
type ampere-hour capacity.

(g) Supports for batteries in buildings shall be furnished in place by the and shall conform to Drawing, dated

(h) Storage battery shall be charged to rated capacity by before placing in service.

26. *Batteries.*—Continued.

(i) The shall furnish with each set of main battery, one hydrometer and one battery thermometer.

(j) Installation of various types of batteries shall be in accordance with Instructions for Batteries and Cells, Manual Parts 14 and 7.

27. *Switchboards and equipment.*

(a) Switchboards and equipment shall be in accordance with Specification 107, Manual Part 153. *R-27-a.

28. *Condensers.*

(a) Condensers shall be of the atmospheric type. *R-28-a.

(b) Condensers shall be located as close to the compressor as practicable. They shall have a radiating surface of 1 sq. ft. per cu. ft. capacity of compressor. Condensers shall be in accordance with specifications and shall be furnished by the and installed by the

29. *Air reservoirs.*

(a) An auxiliary air reservoir for collection of condensation shall be furnished and installed for each condenser or section thereof, for each low spot in the main air pipe and at such other locations as shall be designated by the Purchaser. Each reservoir shall be equipped with stop cock and blow-off pipe extending from bottom of reservoir.

(b) Extra large reservoirs called expansion tanks shall be used to provide a stand-by air supply. These reservoirs shall be properly equipped for drainage. *R-29-b.

(c) All steel reservoirs shall be designed for 150 lbs. per sq. in. working pressure and manufactured and tested in accordance with A.S.M.E. Code for Unfired Pressure Vessels. Cast-iron reservoirs shall be tested to a hydrostatic pressure of 300 lbs. per sq. in.

30. *Air pipe lines.*

(a) Air lines shall be best quality galvanized extra heavy wrought iron pipe for underground service, and galvanized copper-bearing extra heavy steel pipe for service above ground, free from zinc oxide or other foreign matter that may scale off. *R-30-a.

1. Main air lines shall be not less than 2 inches in diameter. *R-30-a-1.

2. Branches to retarders shall be not less than 1½ inches in diameter. *R-30-a-2.

3. Branches to switches or skates shall be not less than ¾ inch in diameter. *R-30-a-3.

* Alternate requisites section.

30. *Air pipe lines.*—Continued.

(b) Pipe 2 inches in diameter and larger shall be lapweld; pipe of lesser diameter may be butt weld.

(c) Each length of pipe larger than $\frac{3}{4}$ in. diameter shall be provided with two metallic thread protectors and one extra heavy galvanized recessed coupling, shipped separately in boxes. Pipes of lesser diameter may be shipped in bundles with one end protected with heavy burlap and the extra heavy galvanized recessed coupling turned on the pipe hand tight.

(d) Expansion joints for pipes 2 inches in diameter or larger shall have an iron body, a brass or iron sleeve and allowance for 6 in. expansion. *R-30-d.

(e) Gate or globe valve shall have brass seat, rising stem, ends for in. pipe and designed for a working air pressure up to 150 lbs. per sq. in. *R-30-e.

(f) Stop cocks, screw unions, combination stop cocks and screw unions for $\frac{3}{4}$ in. pipe or smaller shall be provided with brass seats and designed for a working air pressure up to 150 lbs. per sq. in. *R-30-f.

(g) Flexible connections shall be best quality $1\frac{1}{2}$ in. reinforced or armored hose for retarders and $\frac{1}{2}$ in. for switch or skate mechanisms having 3 in. nipple inserted and securely fastened in each end and having not less than 16 in. of hose between the ends of the nipples. Complete connection shall be capable of withstanding a working pressure of 150 lbs. per sq. in.

(h) All iron pipe fittings, including tees, elbows, street ells, and reducers, shall be A.A.R. Mechanical Division 300 lb. extra heavy malleable iron or steel, galvanized. Galvanizing shall be in accordance with Specification for Metal Plating, Manual Part 63.

(i) Pipe unions between 1 and $1\frac{3}{4}$ in. diameter, inclusive, shall be A.A.R. Mechanical Division 300 lb. extra heavy malleable iron or steel, screw type with ground joint and brass to iron seat, galvanized. Galvanizing shall be in accordance with Specification for Metal Plating, Manual Part 63. *R-30-i.

(j) Branch air line shall be taken from the top of the main air line, the connection being made by means of two street or service "L's" so arranged as to form a hinged joint to provide for expansion or by means of flexible hose.

(k) Expansion joints shall be placed in the main air line not more than 500 ft. apart where pipe is located above ground and 1,500 ft. where pipe is located underground. *R-30-k.

(l) Main air line, when above ground, shall be securely anchored midway between each pair of expansion joints and at ends of line.

(m) Each branch line shall contain a brass cock and union, at or near its connection with the main and if underground shall be adequately protected and accessible.

* Alternate requisites section.

30. *Air pipe lines.*—Continued.

(n) Check valves shall be installed in main air line as designated by Purchaser.

(o) Approved type of air filter shall be installed between each branch line and pneumatically operated unit. *R-30-o.

(p) Main air line shall be in good surface and so graded that condensation will run into suitable drain tanks. Main reservoirs shall be connected in series with the main air line and be provided with by-pass of the same size as the main air line. Flanges, unions, gate valves, etc., shall be provided so that main reservoirs may be removed without interrupting the flow of air through the by-pass.

(q) Pipe line installed in clean gravel or stone ballast shall have no special protection provided. Pipe line installed in cinder or slag ballast shall be wrapped with a corrosion-resisting impregnated reinforced asbestos tape and surrounded by 4 in. of sand or loam.

(r) Air line when placed above the ground parallel to the track shall not be placed nearer than 6 ft. from the gage side of the rail, except by permission of the Purchaser.

(s) Local conditions shall determine the height of the main air line when above ground but in all cases the bottom of the pipe shall be not less than 6 in. above the top of the ground, except by permission of the Purchaser.

(t) Supports for main air line shall be placed not more than 10 ft. apart.

(u) Red lead, graphite or equivalent shall be applied to the pipe threads and only after pipe connections have been started when pipe is coupled.

(v) Each length of pipe and the fittings shall be free from dirt and scale before being coupled in the line, and care shall be exercised that no dirt gets in the line at any time. Pipe lines shall be blown out before being connected to any apparatus.

(w) Galvanizing shall be in accordance with Specification for Metal Plating, Manual Part 63.

31. *Control machine.*

(a) Control machine shall be in accordance with Specification 241, Manual Part, or Specification 245, Manual Part

32. *Communication system.*

(a) Telephone system shall be in accordance with A.A.R. Communications Section Specification.

(b) Telephones or telephone jacks shall be located in suitable housings at locations for communication with control tower as specified by Purchaser.

(c) Loud speaker equipment shall be installed as specified by Purchaser.

* Alternate requisites section.

32. *Communication system.*—Continued.

- (d) Selector equipment shall be installed as specified by Purchaser.
- (e) Teletype system shall be installed as specified by Purchaser.
- (f) Pneumatic message tubes shall be installed as specified by Purchaser.
- (g) Train communication system shall be installed as specified by Purchaser.
- (h) system shall be installed as specified by Purchaser.

33. *Foundations.*

- (a) Foundations shall be rigid, level and parallel to track.
- (b) Elevation and distance of foundations from track shall be in accordance with Purchaser's standard practice.
- (c) Dimensions of concrete foundations shall conform to Drawing, dated
- (d) Concrete foundations shall be allowed to properly set before any apparatus is connected thereto or placed thereon.
- (e) Foundations shall be so constructed that apparatus can be removed without disturbing foundations.
- (f) The Purchaser and Contractor shall jointly decide when deviations from specified sizes are necessary.

34. *Anchor bolts.*

- (a) Anchor bolts for ground mast signals shall conform to Drawing 1107 or 1259.
- (b) Anchor bolts for other foundations shall be in accordance with Purchaser's standard.
- (c) Threads of anchor bolts shall not be imbedded in concrete foundations.
- (d) Bolt holes in base castings shall be filled with waterproof and rust-resisting compound.

35. *Concrete.*

- (a) Concrete shall be 1-2-4 mixture and in accordance with Specification, dated *R-35-a.

36. *Car retarder.*

- (a) Car retarder shall be in accordance with Specification 242, Manual Part, or Specification 246, Manual Part

37. *Switch operating mechanism.*

- (a) Switch operating mechanism shall be in accordance with Specification 243, Manual Part, or Specification 247, Manual Part

* Alternate requisites section.

38. *Switch fittings.*

(a) Gage plates and rail braces shall be in accordance with Purchaser's specifications.

(b) Switch operating rods shall be in accordance with Purchaser's specifications.

(c) Arrangement and support of connections shall be such that switch points can be stopped by placing an obstruction between point and stock rail at any point of the stroke, without breaking or bending any such connections.

39. *Skate operating mechanism.*

(a) Skate operating mechanism shall be in accordance with Specification 244, Manual Part, or Specification 248, Manual Part

40. *Skates.*

(a) Skates shall be in accordance with Manufacturer's standard.

41. *Signal system.*

(a) Hump signal shall conform to the following drawings or references:

1.
2.

(b) Repeater signal shall conform to the following drawings or references:

1.
2.

*(c) Trimmer signal shall conform to the following drawings or references:

1.
2.

(d) Switch signal shall conform to the following drawings or references:

1.
2.

(e) Cab signals shall be as specified by the Purchaser.

(f) Audible signals shall be as specified by the Purchaser.

(g)

42. *Detector track circuits.*

(a) Track circuits shall be provided as shown on Drawing, dated *R-42-a.

(b) Track circuits shall be direct current and shall conform to Drawing 1639. *R-42-b.

* Alternate requisites section.

43. *Switch control circuits.*

(a) Switch control circuits shall be so designed that the position of the switch points will at all times correspond to the position of the machine lever except where track circuit control is provided.

(b) Where track circuit control is provided, switch control circuits shall be in accordance with the Manufacturer's standard practice, subject to modifications to meet Purchaser's requirements, if found necessary. *R-43-b.

44. *Switchboard circuits.*

(a) Contractor's recommended arrangement of circuits shall be followed, subject to modification to meet Purchaser's special requirements.

45. *Electric lighting circuits.*

(a) Circuits for electric lights shall conform to plan submitted by the Purchaser.

(b) The maximum allowable drop in potential on electric lighting circuits from switchboard to any lamp shall be 10 per cent.

(c) Alternating current at volts, cycles distribution and volts, watt lamps shall be used. *R-45-c.

46. *Special circuits.*

(a) The special circuit requirements, in detail, are as follows:

1.
2.

47. *Wires and cables.*

(a) Wires and cables shall be in accordance with the following specifications (*R-47-a):

1. Copper-Bearing Steel Wire with or without Weather-Resistant Covering—Specification 196, Manual Part 181.
2. Specification for Galvanized Steel Strand, Manual Part 184.
3. Copper-Covered Steel Wire with or without Weather-Resistant Coverings—Specification 167, Manual Part 180.
4. Copper Alloy Wire with or without Weather-Resistant Covering—Specification 168, Manual Part 173.
5. Hard-Drawn Copper Wire with or without Weather-Resistant Covering—Specification 169, Manual Part 182.
6. Single-Conductor Insulated Wire and Cable with Flame-Retarding, Moisture-Resistant or Weather-Resistant Braid Covering or Outer Polychloroprene Sheath—Specification 111, Manual Part 186.

* Alternate requisites section.

47. *Wires and cables.*—Continued.

7. Aerial Aluminum Cable Steel Reinforced—Specification 54, Manual Part 24.

8. Multiple-Conductor Insulated Cable with Weather-Resistant or Flame-Retarding Moisture-Resistant Braid Covering—Specification 89, Manual Part 25.

9. Multiple-Conductor Insulated Submarine Cable, Lead Sheathed and Round Steel Armored—Specification 90, Manual Part 26.

10. Single and Multiple-Conductor Insulated Lead Sheathed Cable—Specification 91, Manual Part 28.

11. Single and Multiple-Conductor Insulated Lead-Covered Parkway Cable, Armored with Flat Steel or Zinc Tape—Specification 145, Manual Part 20.

12. Single and Multiple-Conductor, Insulated, Non-Metallic Sheathed Cable—Specification 161, Manual Part 36.

13.

14.

48. *Size of wire.*

(a) Wire shall be of sufficient size to permit operation of car retarder, skate, switch and signal operating mechanisms in accordance with this specification.

(b) Single-conductor wires external to the control tower shall be not smaller than No. 14 A.W.G. Single-conductor wires within the control tower shall be not smaller than No. 16 A.W.G.

(c) Wires in cable external to the control tower shall be not smaller than No. 16 A.W.G.

(d) Line wires shall be not smaller than No. 10 A.W.G. for hard-drawn copper or No. 12 A.W.G. for copper-covered steel.

(e) In cables, spare wires shall be provided as designated by the Purchaser.

(f) Size and description of circuit conductors shall be as follows:

	Make (a)	A.W.G. (b)	Material (c)	Wall of rubber insula- tion (d)	Braid (e)	Tape (f)
1. Track transformers or batteries to rail.....						
2. Relay to each rail.....						
3. Fouling shunt connections.....						
4. Series track connections.....						
5. Switch circuit controller shunt connections.....						

48. *Size of wire.*—Continued.

	Make (a)	A.W.G. (b)	Material (c)	Wall of rubber insula- tion (d)	Braid (e)	Tape (f)
6. Line drops.....						
7. Power line drops.....						
8. Signal wires.....						
9. Switch wires.....						
10. Ground wires.....						
11. Signal lighting wires.....						
12. Inside wiring (cases, etc.).....						
13. Aerial wire.....						
14. Transmission line.....						
15. Retarder controls.....						
16. Skate controls.....						
17. Relay leads.....						
18. Aerial cables.....						
19. Underground cables.....						
20. Submarine cables.....						
21.						

49. *Wiring.*

(a) Wiring shall be in accordance with Specification 119, Manual Part 84.

(b) Lead cable underground without other mechanical protection shall be placed in conduit.

50. *Overload devices.*

(a) Fuses shall be:

	Type	Voltage	Capacity
1.			
2.			

(b) Fuse clips shall be mounted on an insulating base of fire-proof material.

(c) Circuit breakers shall be:

	Type	Voltage	Capacity
1.			
2.			

(d) Fuses or circuit breakers shall be installed according to Contractor's standard practice as approved by Purchaser. *R-50-d.

(e) Fuses or circuit breakers outside of buildings shall be enclosed in weatherproof housings.

* Alternate requisites section.

51. *Bonding.*

- (a) Bonding shall be type, and installed in accordance with Specification 135, Manual Part 22.

52. *Relays.*

(a) Direct current relays.

1. Tractive armature d.c. neutral relays shall be in accordance with Specifications 105 and 154, Manual Parts 123 and 101.

(a) Track relays shall be of ohms resistance and have not more than nor less than contact fingers.

(b) Line relays shall be of ohms resistance and have not more than nor less than contact fingers.

2. Tractive armature d.c. polarized relays shall be in accordance with Specification 165, Manual Part 137.

(a) Track relays shall be of ohms resistance and have not more than nor less than contact fingers on neutral armatures and not more than nor less than contact fingers on polar armatures.

(b) Line relays shall be of ohms resistance and have not more than nor less than contact fingers on neutral armatures and not more than nor less than contact fingers on polar armatures.

3. Tractive armature d.c. neutral relays, plug-in type, shall be in accordance with Specification 204, Manual Part 77.

4. Other types of d.c. relays shall be as follows:

(a)
(b)

(b) Alternating current relays.

1. Relays shall be of the following type:

(a)
(b)

2. Alternating current relays shall be in accordance with Specifications 78 and 148, Manual Parts 122 and 53.

3. Track relays shall operate on and have contact fingers:
(a) Single-element volts cycles and not more than nor less than contact fingers.

(b) Two-element relays shall have not more than nor less than contact fingers and shall have windings for operation on:

1. Track winding volts cycles.

2. Local winding volts cycles.

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65. *Insulated rail joints.*

(a) Insulated joints shall be type and for
section, lb. rail with hole drilling.

(b) Insulated joints shall be installed in accordance with
Instructions for Insulated Rail Joints, Manual Part 133.

66. *Switch-rod insulation.*

(a) Switch-rod insulation shall conform to Drawing 1055.
*R-66-a.

67. *Fibre insulation.*

(a) Fibre insulation shall be in accordance with Specification
13, Manual Part 58.

68. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specifi-
cation 120, Manual Part 110.

69. *Padlocks.*

(a) Purchaser's padlocks shall be furnished by and
shall be used where specified.

70. *Special items.*

(a)
.....

Alternate requisites.

R-3-b-2.

After the award of contract and before work is begun, the
Purchaser shall furnish the following drawings as scheduled by
the Purchaser:

(a) Track plan showing retarders, switches, signals,
skate mechanisms, relays, transformers, and batteries and
their locations, within days.

(b) Detail circuit plans, within days.

(c) Instrument case wiring plans, within days.

(d) Cable diagram, within days.

(e) Air line diagram, within days.

R-3-b-11.

Track diagrams shall be furnished in place in control towers
by Purchaser.

R-7-a.

Contractor will furnish transportation for men, necessary for
the installation, over the following lines:

* Alternate requisites section.

Alternate requisites.—Continued.

R-7-b.

Contractor will furnish transportation for tools and material, necessary for the installation, over the following lines:.....

R-7-c.

Purchaser will not furnish work train service for distribution of material.

R-7-d.

Purchaser will not furnish work train service for erection of apparatus.

R-7-e.

Purchaser will not furnish derrick service for erection of apparatus.

R-9-b-4-e.

Test of switches to determine proper operation at prescribed minimum air pressure or operating voltage and that the time from the throwing of the controlling switch lever to the completion of the switch movement shall, under normal operating conditions, occur in not more than seconds.

R-10-a.

Purchaser will place the installation in service in the event that he does not authorize the Contractor to do so within days after completion of the work to the Purchaser's satisfaction.

R-12-a.

Clearances shall conform to Purchaser's clearance diagram, Drawing, dated

R-20-a.

1. Air compressor and foundation shall not be furnished.
2. Foundation shall be furnished by Purchaser.

R-20-b.

Automatic governors shall not be provided.

R-20-d.

Duplicate panels shall not be provided.

R-20-e.

Air compressors shall be driven.

R-23-a.

Motor-generator shall not be direct-connected.

Alternate requisites.—Continued.

- R-27-a. Switchboard shall be in accordance with
- R-28-a. Condensers shall be of the type.
- R-29-b. Extra large reservoirs called expansion tanks to provide a stand-by air supply shall not be used.
- R-30-a. Air lines shall be
- R-30-a-1. Main air lines shall be inches in diameter.
- R-30-a-2. Branches to retarders shall be inches in diameter.
- R-30-a-3. Branches to switches or skates shall be inches in diameter.
- R-30-d. Expansion joints for pipes 2 inches in diameter or larger shall have
- R-30-e. Gate or globe valve shall have
- R-30-f. Stop cocks, screw unions, combination stop cocks and screw unions for $\frac{3}{4}$ in. pipe or smaller shall be
- R-30-i. Flange unions shall be of forged steel.
- R-30-k. Expansion joints shall be placed in the main air line not more than ft. apart where pipe is located above ground and ft. where pipe is located underground.
- R-30-o. Air filter shall not be furnished.
- R-35-a. Concrete shall be mixture in accordance with Specification, dated

Alternate requisites.—Continued.

R-42-a.

Track circuits shall not be provided.

R-42-b.

Track circuits shall be:

1. Alternating current.

2. Alternating current rectified.

3.

R-43-b.

Where track circuit control is provided, switch control circuits shall be so arranged that if the switch is trailed, switch points shall be held in the trailed position until detector track circuit is cleared, at which time the switch points shall assume a position in agreement with that of the control machine lever.

R-45-c.

Direct current at volts distribution and volts, watt lamps shall be used.

R-47-a.

Wires and cables shall be in accordance with

R-50-d.

Fuses or circuit breakers shall be installed as follows:

R-54-a.

Switch circuit controllers shall be

R-54-b.

Switch circuit controller connections shall conform to

R-57-a.

Track circuit connectors shall conform to Drawing, dated

R-66-a.

Switch-rod insulation shall conform to Drawing, dated

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 147-40—Car Retarder System, Manual Part 27.

A.A.R. SIGNAL SECTION SPECIFICATION 245-49.

ELECTRIC CAR RETARDER CONTROL MACHINE

1. *Purpose.*

(a) This specification is for the purpose of providing a machine for the control of car retarders, switches, signals, skates and other apparatus of an electric car retarder system. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings form an essential part of this specification and should contain the following information:

1. Track plan of hump end of classification yard, present or future, or both, showing the turnouts and switches to be power-operated, the car retarders, skates and other apparatus to be controlled by car retarder control machine. Drawing, dated

2. Other standards and drawings. Drawing, dated

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Machine shall conform to the following drawings or references:

1.
2.

(b) Machine shall include the following features:

1.
2.
3. Car retarder, switch, signal and skate levers.
4. Lights for indicating the position of the switches.

6. *Design.*—Continued.

5. Space for cut-list.
6. Illumination for top of machine. *R-6-b-6.
7. Space for operator's knees.
8. Means for blocking switch levers.
- (c) Machine shall be designed for the control of circuits, the maximum voltage of which shall be not more than 265 volts d.c.
- (d) Like parts of same Manufacturer's machine shall be interchangeable.
- (e) Bolts and screws shall have National Standard thread. *R-6-c.
- (f) Where practicable, nut, bolt and cap screw heads shall be hexagonal.
- (g) Bolts and cap screws shall be provided with spring lock washers where practicable.
- (h) Tapered dowel pins shall be standard $\frac{1}{4}$ in. per ft.
- (i) Moving parts of machine shall work freely and without lost motion, and provision made to permit necessary lubrication.

7. *Machine levers.*

- (a) Levers shall be numbered in accordance with layout plan, shall have uniform throw and hold in each position.
- (b) Levers of like character shall have equal and uniform throw for each position and shall be true in alignment.
- (c) Levers shall be so arranged that they can be removed without interfering with operation of other levers.
- (d) Car retarder levers shall be six-position. *R-7-d.
- (e) Skate levers shall be two-position.
- (f) Switch levers shall be two-position.
- (g) Signal levers shall be two-position. *R-7-g.
- (h) Spare levers shall be furnished in place complete, ready for operation and control of their respective units, as follows (*R-7-h):

1.
2.

8. *Light indicators.*

- (a) Indicators shall be provided as follows:
 1.
 2.
 3. For indicating the position of the switches.
- (b) Indicators shall be located on machine as close as practicable to their respective levers.
- (c) Electric lamps for indicators shall be in accordance with Specification 51, Manual Part 91, and shall have C-21 filament, SL.1 slide telephone switchboard base, T-2 bulb, rated at 12 volts, 0.09 to 0.11 ampere. *R-8-c.

* Alternate requisites section.

52. *Relays.*—Continued.

4. Line relays shall operate on and have contact fingers:
 - (a) Single-element volts cycles and not more than nor less than contact fingers.
 - (b) Two-element relays shall have not more than nor less than contact fingers and shall have windings for operation on:
 1. Line winding volts cycles.
 2. Local winding volts cycles.
 5. Other types of a.c. relays shall be as follows:
 - (a)
 - (b)
- (c) Relays shall be provided with spare contacts as follows:
 1.
 2.

53. *Reactors and resistors.*

- (a) Reactors shall be in accordance with Specification 104, Manual Part 121.
- (b) Resistors shall be in accordance with Specification 106, Manual Part 135.

54. *Circuit controllers.*

- (a) Universal switch circuit controllers shall be in accordance with Specification 95, Manual Part 49. *R-54-a.
- (b) Switch circuit controller connections shall conform to Drawings 1255, 1256, 1271 and 1272. *R-54-b.
- (c) Switch circuit controllers shall be connected to the near switch point.
- (d) circuit controllers shall be in accordance with

55. *Lightning arresters.*

- (a) Line arresters, type, shall meet A.I.E.E. requirements and shall be installed as shown on circuit drawings.
- (b) Low-voltage arresters, type, shall meet the requirements of Specification 52, Manual Part 95, and shall be installed as shown on circuit drawings.
- (c) Arrester grounds shall be in accordance with Specification 60, Manual Part 92. Contractor's liability is limited to grounding elements per ground.
- (d) Separate grounds shall be provided for high-tension and low-tension lightning arresters.

* Alternate requisites section.

11. *Case.*

- (d) Binding posts shall be spaced not less than 1 in. centers.
- (c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.
- (b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 107010, for field wire connections.
- (a) Binding posts, nuts, and washers shall conform to Drawing 1070, assembly 107010, or soldered terminals, shall be used where no field wires are connected to such terminals.

10. *Binding posts.*

- (c) The movement of the contact members shall be such as will insure a wiping contact.
- (b) Contact members shall be made of corrosion-resisting metal of sufficient mechanical strength and current-carrying capacity to satisfactorily operate in connection with the circuits used.
- (a) Machine shall be equipped with circuit controllers approved by the Purchaser. *R-9-a.

9. *Circuit controllers.*

15. *Coil insulation.*

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(c) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum wall thickness of $\frac{1}{16}$ in.

(d) Insulating material used for fillers in winding coils shall be chemically neutral.

(e) Coils shall be so insulated that they will withstand the insulation test provided in section 16. This test shall be made by mounting coil on a snugly fit metal mandrel and making breakdown tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

16. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 1,500 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{8}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 1,500 volts a.c. between their terminals.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings without any excessive flow of current indicating a short circuit.

17. *Identification.*

(a) Magnet coils and resistors shall be plainly marked with Manufacturer's references.

18. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

60. *Conduits.*
(a) Conduits shall be in accordance with A.A.R. Communications Section Specification.
59. *Terminal boxes.*
(a) Terminal boxes shall conform to Drawing dated
58. *Junction boxes.*
(a) Junction boxes shall conform to Drawing dated
(b) Junction boxes shall be located as shown on Drawing dated
57. *Track circuit connectors.*
(a) Track circuit connectors shall conform to Drawing 1632. *R-57-a.
56. *Bootlegs.*
(a) Bootlegs shall conform to Drawing dated

18. *Inspection.*—Continued.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

19. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

20. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

21. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

22. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-6-b-6.

No provision for illuminating top of machine.

R-6-e.

1. Bolts shall have thread.
2. Screws shall have thread.
3.

R-7-d.

Car retarder levers shall be position.

R-7-g.

Signal levers shall be position.

R-7-h.

Space for spare levers shall be furnished as follows:

1.
2.

R-8-c.

Electric lamps for indicators shall have filament,
 base, bulb, rated at volts,
 amperes, or watts, or candle-
 power.

R-9-a.

Machine shall be equipped with Manufacturer's standard
 circuit controllers.

R-11-b.

Machine case shall be equipped for padlocks.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 241-49.

ELECTRO-PNEUMATIC CAR RETARDER CONTROL MACHINE

1. *Purpose.*

(a) This specification is for the purpose of providing a machine for the control of car retarders, switches, signals, skates and other apparatus of an electro-pneumatic car retarder system. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings form an essential part of this specification and should contain the following information:

1. Track plan of hump end of classification yard, present or future, or both, showing the turnouts and switches to be power-operated, the car retarders, skates and other apparatus to be controlled by car retarder control machine. Drawing, dated

2. Other standards and drawings. Drawing, dated

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Machine shall conform to the following drawings or references:

1.
2.

(b) Machine shall include the following features:

1.
2.
3. Car retarder, switch, signal and skate levers.
4. Lights for indicating the position of the switches.

6. *Design.*—Continued.

5. Space for cut-list.

6. Illumination for top of machine. *R-6-b-6.

7. Space for operator's knees.

8. Means for blocking and locking switch levers.

(c) Machine shall be designed for the control of circuits, the maximum voltage of which shall be volts d.c., and where special requirements are to be met amperes.
*R-6-c.

(d) Like parts of same Manufacturer's machine shall be interchangeable.

(e) Bolts and screws shall have National Standard thread.
*R-6-e.

(f) Where practicable, nut, bolt and cap screw heads shall be hexagonal.

(g) Bolts and cap screws shall be provided with spring lock washers where practicable.

(h) Tapered dowel pins shall be standard $\frac{1}{4}$ in. per ft.

(i) Moving parts of machine shall work freely and without lost motion, and provision made to permit necessary lubrication.

7. *Machine levers.*

(a) Levers shall be numbered in accordance with layout plan, shall have uniform throw and hold in each position.

(b) Levers of like character shall have equal and uniform throw for each position and shall be true in alignment.

(c) Levers shall be so arranged that they can be removed without interfering with operation of other levers.

(d) Car retarder levers shall be five-position.

(e) Skate levers shall be two-position.

(f) Switch levers shall be two-position.

(g) Signal levers shall be two-position. *R-7-g.

(h) Spare levers shall be furnished in place complete, ready for operation and control of their respective units, as follows (*R-7-h):

1.
2.

8. *Light indicators.*

(a) Indicators shall be provided as follows:

1.
2.
3. For indicating the position of the switches.

(b) Indicators shall be located on machine as close as practicable to their respective levers.

(c) Electric lamps for indicators shall be in accordance with Specification 51, Manual Part 91, and shall have C-21 filament, SL2 slide telephone switchboard type base, T-2 bulb, rated at 8 volts, 0.085-0.10 ampere. *R-8-c.

* Alternate requisites section.

9. *Circuit controllers.*

(a) Machine shall be equipped with circuit controllers approved by the Purchaser. *R-9-a.

(b) Contact members shall be made of corrosion-resisting metal of sufficient mechanical strength and current-carrying capacity to satisfactorily operate in connection with the circuits used.

(c) The movement of the contact members shall be such as will insure a wiping contact.

10. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, detail 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

11. *Case.*

(a) Machine shall be enclosed in a metal case which shall have removable covers or panels, or both, of convenient size to permit free access to all parts.

(b) The case shall be equipped for Purchaser's padlock.
*R-11-b.

12. *Wire and wiring.*

(a) Insulated wire shall be in accordance with Specification 111, Manual Part 186.

(b) Machine wiring shall be with stranded insulated wire not less than No. 18 A.W.G.

(c) Wiring shall be neatly arranged and securely fastened.

13. *Finish.*

(a) Metal parts shall be protected against corrosion except where such protection will interfere with the proper functioning of that part.

(b) Material used for protection against corrosion shall neither soften nor flake under ordinary conditions between temperatures of 40 deg. F. below zero and 185 deg. F. above zero.

14. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110, Manufacturer's standard color.

* Alternate requisites section.

15. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 1,500 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{8}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

16. *Identification.*

(a) Equipment shall be plainly marked with Manufacturer's references.

17. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

18. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

19. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

20. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

21. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-6-b-6.

No provision for illuminating top of machine.

R-6-c.

Machine shall be designed for the control of circuits, the maximum voltage of which shall be

R-6-e.

1. Bolts shall have..... thread.
2. Screws shall have..... thread.
3.

R-7-g.

Signal levers shall be position.

R-7-h.

Space for spare levers shall be furnished as follows:

1.
2.

R-8-c.

Electric lamps for indicators shall have filament,
..... base, bulb, rated at volts,
..... amperes, or watts, or candle-
power.

R-9-a.

Machine shall be equipped with Manufacturer's standard circuit controllers.

R-11-b.

Machine case shall be equipped for padlocks.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 246-49.

ELECTRIC CAR RETARDER

1. *Purpose.*

(a) This specification is for the purpose of providing an electrically operated car retarder for controlling the speed of cars in classification yards. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Retarder shall conform to the following drawings or references:

1.
2.

(b) Apparatus shall be so designed that it may be applied to either or both rails, and shall be so constructed that it will withstand twice the maximum stress without damage to any of the parts.

(c) Retarder shoes shall be made of steel.

(d) Retarder shall be so designed that shoe pressure is applied in four approximately equal steps.

(e) Shoe pressures on car wheels shall be equalized as nearly as possible to reduce the lifting effect of the retarder and increase its efficiency.

6. *Design.*—Continued.

(f) Lubrication.

1. Moving parts shall work freely, without lost motion and provision shall be made for proper and convenient lubrication.

(g) Foundation.

1. When retarders are to be mounted on concrete foundations, Purchaser shall furnish drawings of such foundations.

(h) Retarders shall be so designed that, if desired, an insulated joint can be installed within the retarder and the two sides of the retarder can be insulated from each other.

(i) Adjustment shall be provided to compensate for retarder shoe wear.

7. *Clearance.*

(a) Height of retarder brake shoes above the rail with the retarder in the open position shall not exceed $2\frac{1}{2}$ in. for the inside shoe and 2 in. for the outside shoe.

(b) The distance between the retarder brake shoes, with the retarder in the open position, shall be sufficient to clear the car and locomotive wheels.

8. *Operating mechanism.*

(a) Mechanism shall conform to the following drawings or references:

1.
2.

(b) Apparatus shall be so designed as to permit its being firmly secured in fixed relation to the track.

(c) Mechanism shall be enclosed in a substantial metallic weatherproof case, the cover of which shall be removable and equipped with suitable fastenings for application of Purchaser's padlock, and when open shall provide access to all parts.

(d) Mechanism case shall be provided with wire entrance of ample size, conveniently located for access to binding posts, equipped with adapter castings and flexible conduit, arranged to protect wires from mechanical injury. *R-8-d.

(e) Moving parts shall work freely, without lost motion, and provision shall be made for proper and convenient lubrication.

(f) Contact members shall be made of corrosion-resisting metal of sufficient mechanical strength and current-carrying capacity to satisfactorily operate in connection with the circuits used.

(g) Movement of the contact members shall be such as will insure a wiping contact.

(h) Motor.

1. Motor shall be enclosed in a substantial metallic weatherproof case, the cover of which shall be equipped with

* Alternate requisites section.

8. *Operating mechanism.*—Continued.

suitable fastenings for application of Purchaser's padlock, and when open shall permit access to terminals, commutator and brushes, or their equivalent.

2. The motor shall be capable of delivering, without injury, the torque necessary for the most severe operating conditions.

3. Motor shall be attached to and form a part of the mechanism, and shall be removable therefrom.

4. Case shall be provided with wire entrance of ample size, conveniently located for access to binding posts, and arranged to protect wires from mechanical injury.

5. Motor shall be designed for:

(a) voltage range d.c.

(b) voltage range cycles a.c.

(i) *Bearings.*

1. Bearings shall be of ample dimensions to insure reasonable durability.

2. Provision shall be made for proper and convenient lubrication of mechanism.

3. Motor shall be designed to prevent oil from bearings getting on brushes, commutator or windings.

4. Exposed oil holes shall be provided with weatherproof oil cups or covers.

9. *Controller for car retarder.*

(a) The controller for the car retarder mechanisms shall comprise a substantial metallic housing arrangement with the required control and protective equipment. The housing shall be weatherproof with doors provided with a durable tight gasket and a hasp lug with a minimum opening of $\frac{1}{2}$ in. for a padlock, and shall have facilities for wire entrance and mounting.

(b) The control and protective equipment for each mechanism shall be mounted on an ebony asbestos panel located in the housing in such a manner as to permit access to both front and back. Binding posts for power and control circuits shall be mounted at bottom of panel.

(c) Switches for opening the d.c. power supply to the controller shall be mounted on an ebony asbestos terminal board with the required power busses and binding posts.

(d) The size of each housing and the number of panels mounted therein shall be such as to handle to best advantage the various groups of retarder layouts in the yard.

(e) The mechanism shall operate on 230 volts d.c. and the control for its protective equipment shall be at 115 volts d.c.

10. *Wiring.*

(a) Internal wiring shall be neatly arranged and so located that it will not be subject to damage.

(b) Wire for internal wiring shall be stranded insulated and shall be not less than No. 16 A.W.G. Wire eyelet shall be provided at each end and soldered in, or other suitable terminal provided.

11. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

12. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

13. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test at place of manufacture, of 1,500 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 1,500 volts a.c. between their terminals.

14. *Identification.*

(a) Mechanism shall be plainly marked with Manufacturer's references.

15. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what dispo-

15. *Inspection.*—Continued.

sition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

16. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

17. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

18. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

19. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-8-d.

Mechanism case shall be provided with cable entrance.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 242-49.

ELECTRO-PNEUMATIC CAR RETARDER

1. *Purpose.*

(a) This specification is for the purpose of providing an electro-pneumatically operated car retarder for controlling the speed of cars in classification yards. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Retarder shall conform to the following drawings or references:

1.
2.

(b) Apparatus shall be so designed that it may be applied to either or both rails, and shall be so constructed that it will withstand twice the maximum stress without damage to any of the parts.

(c) Retarder shoes shall be made of steel.

(d) Retarder shall be so designed that shoe pressure is applied in four approximately equal steps.

(e) Shoe pressures on car wheels shall be equalized as nearly as possible to reduce the lifting effect of the retarder and increase its efficiency.

6. *Design.*—Continued.

(f) Lubrication.

1. Moving parts shall work freely, without lost motion, and provision shall be made for proper and convenient lubrication.

(g) Foundation.

1. When retarders are to be mounted on concrete foundations, Purchaser shall furnish drawings of such foundations.

(h) Retarders shall be so designed that, if desired, an insulated joint can be installed within the retarder and the two sides of the retarder can be insulated from each other.

(i) Means shall be provided for cutting off the air supply from the whole retarder and from each individual cylinder.

7. *Clearance.*

(a) Height of retarder brake shoes above the rail with the retarder in the open position shall not exceed $2\frac{1}{4}$ in.

(b) The distance between the retarder brake shoes, with the retarder in the open position, shall be 7 in. *R-7-b.

8. *Electro-pneumatic control valve and pressure regulator.*

(a) Valve and pressure regulator shall conform to the following drawings or references:

1.
2.

(b) Electro-pneumatic control valve and pressure regulator shall be enclosed in a substantial metallic ventilated weather-proof case designed for mounting independent of the retarder mechanism, the covering of which case shall be removable and equipped with suitable fastenings for application of Purchaser's padlock, and when open shall permit access to all parts.

(c) Contact members shall be made of corrosion-resisting metal of sufficient mechanical strength and current-carrying capacity to satisfactorily operate in connection with the circuits used.

(d) Movement of the contact members shall be such as will insure a wiping contact.

(e) Cut-out switch shall be provided at the control valve to facilitate working on retarder and adjusting it.

(f) Pressure regulator shall be of a type to provide the predetermined air pressures necessary for the operation of the retarder at different retarding capacities.

(g) The case shall be provided with one opening for all wires entering the case, and shall be equipped with adapter castings and flexible connections when the case is mounted on ties.

(h) Air strainer of sufficient size and so constructed as to insure an adequate supply of air free from foreign substance that may

* Alternate requisites section.

8. *Electro-pneumatic control valve and pressure regulator.*—Continued.
interfere with the operation of the valves or cylinders shall be provided, and shall be easily removed for cleaning.

- (i) Pipe entrance shall be of ample size and conveniently located for external connections.
- (j) Each valve magnet shall be enclosed in a metallic shell.
- (k) Magnets shall be designed for operation at 14 volts d.c.
- (l) Magnets shall operate satisfactorily when the voltage is reduced 20 per cent below rated voltage.

9. *Binding posts.*

- (a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.
- (b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.
- (c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.
- (d) Binding posts shall be spaced not less than 1 in. centers.

10. *Paint and painting.*

- (a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

11. *Insulation.*

- (a) Wire for coils shall be soft-drawn copper covered with enamel insulation, in accordance with Specification 193, Manual Part 183.
- (b) Coils shall be impregnated or otherwise treated so as to satisfactorily protect the wire from moisture under all service conditions.
- (c) Impregnating compound when used, shall be in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

12. *Dielectric requirements.*

- (a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.
- (b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.
- (c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

13. *Identification.*

(a) Valve and pressure regulator shall be plainly marked with Manufacturer's references.

(b) Magnet coils shall be plainly marked with Manufacturer's references.

14. *Inspection.*

(a) The material furnished under this specification may be accepted upon Manufacturer's certificates of guarantee insuring that it is in accordance with the specification. If, upon arrival at destination, the material is found not to meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

15. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

16. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

17. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

18. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired

18. *Warranty.*—Continued.

or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-7-b.

The distance between the retarder brake shoes in the open position shall be $9\frac{1}{4}$ in.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 247-49.

ELECTRIC SWITCH OPERATING MECHANISM FOR YARDS

1. *Purpose.*

(a) This specification is for the purpose of providing an electric switch operating mechanism for yards. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Mechanism shall conform to the following drawings or references:

1.
2.

(b) Mechanism shall be so designed as to permit its being secured in fixed relation to the track.

(c) Switch mechanism shall be so designed that trailing movements through the switch points will not damage the mechanism.

(d) The mechanism shall be enclosed in a substantial metallic case, the cover of which shall be removable and equipped with suitable fastenings for application of Purchaser's padlock, and when open shall provide access to all parts.

(e) Mechanism case shall be provided with wire entrance of ample size, conveniently located for access to binding posts, equipped with adapter castings and flexible conduit, arranged to protect wires from mechanical injury. *R-6-e.

* Alternate requisites section.

6. *Design.*—Continued.

(f) Moving parts shall work freely, without lost motion, and provision shall be made for proper and convenient lubrication.

(g) Mechanism shall be so designed that it may be used for either right or left-hand operation.

(h) Mechanism shall be designed to give at least a $5\frac{1}{2}$ in. throw of the switch operating rod. Mechanism shall give complete operation in sufficient time to meet the over-all operating time of 1.2 seconds as required by section 9-b-4-e in Specification 147, Manual Part 27. *R-6-h.

(i) Motor.

1. Motor shall be enclosed in a substantial metallic weatherproof case, the cover of which shall be equipped with suitable fastenings for application of Purchaser's padlock, and when open shall permit access to terminals, commutator and brushes, or their equivalent.

2. The motor shall be capable of delivering, without injury, the torque necessary for the most severe operating conditions.

3. Motor shall be attached to, and form a part of, the mechanism and shall be removable therefrom.

4. Case shall be provided with wire entrance of ample size, conveniently located for access to binding posts, and arranged to protect wires from mechanical injury.

5. Motor shall be designed for:

(a) voltage range d.c.

(b) voltage range cycles a.c.

(j) Contact members shall be made of corrosion-resisting metal of sufficient mechanical strength and current-carrying capacity to satisfactorily operate in connection with the circuits used.

(k) Movement of the contact members shall be such as will insure a wiping contact.

(l) Bearings.

1. Bearings shall be of ample dimensions to insure reasonable durability.

2. Provision shall be made for proper and convenient lubrication of mechanism.

3. Motor shall be designed to prevent oil from bearings getting on brushes, commutator or windings.

4. Exposed oil holes shall be provided with weatherproof oil cups or covers.

7. *Wiring.*

(a) Internal wiring shall be neatly arranged and placed in ducts or channels of ample capacity forming an integral part of the apparatus.

* Alternate requisites section.

7. *Wiring.*—Continued.

(b) Wire for internal wiring shall be insulated and of strands of tinned or leaded copper not larger than No. 27 A.W.G. wire. The aggregate cross-section of the strands shall be not less than No. 16 A.W.G. wire. Wire eyelet shall be provided at each end and soldered in, or other suitable terminal provided.

8. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

9. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

10. *Coil insulation.*

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(c) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum wall thickness of $\frac{1}{16}$ in.

(d) Insulating material used for fillers in winding coils shall be chemically neutral.

(e) Coils shall be so insulated that they will withstand the insulation test provided in section 11. This test shall be made by mounting coil on a snugly fit metal mandrel and making breakdown tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

11. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings without any excessive flow of current indicating a short circuit.

12. *Identification.*

(a) Mechanism shall be plainly marked with Manufacturer's references.

(b) Magnet coils shall be plainly marked with Manufacturer's references.

13. *Inspection.*

(a) The material furnished under this specification may be accepted upon Manufacturer's certificates of guarantee insuring that it is in accordance with the specification. If, upon arrival at destination, the material is found not to meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

14. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

15. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

16. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

17. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-6-e.

Mechanism case shall be provided with cable entrance.

R-6-h.

Mechanism shall be designed to give at least $5\frac{1}{2}$ in. throw of the switch operating rod and shall give complete operation in seconds at volts in bench test with no load on its operating rod.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 243-49.

ELECTRO-PNEUMATIC SWITCH OPERATING
MECHANISM FOR YARDS1. *Purpose.*

(a) This specification is for the purpose of providing an electro-pneumatic switch mechanism for yards. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Mechanism shall conform to the following drawings or references:

1.
2.

(b) Mechanism shall be so designed as to permit it being secured in fixed relation to the track.

(c) Switch mechanism shall be so designed that trailing movements through the switch points will not damage the mechanism.

(d) Mechanism shall be designed to operate on air pressures between 80 and 105 lbs. per sq. in.

(e) The switch cylinder and valves shall be enclosed in a substantial metallic case, the cover of which shall be removable and equipped with suitable fastenings for application of Purchaser's padlock, and when open shall provide access to all parts.

6. *Design.*—Continued.

The case shall be provided with one wire opening for all wires entering the case.

(f) Moving parts shall work freely, without lost motion, and provision shall be made for proper and convenient lubrication.

(g) Mechanism shall be so designed that it may be used for either right or left-hand operation.

(h) Mechanism shall be designed to give at least a $5\frac{1}{2}$ in. throw of the switch operating rod. Mechanism shall give complete operation in sufficient time to meet the over-all operating time of 1.2 seconds as required by section 9-b-4-e in Specification 147, Manual Part 27. *R-6-h.

(i) Airstrainer of sufficient size, and so constructed as to insure an adequate supply of air free from foreign substance that may interfere with the operation of the valves or cylinder, shall be furnished by the Purchaser.

(j) Pipe entrance shall be of ample size and conveniently located for external connections.

(k) Each valve magnet shall be enclosed in a metallic shell.

(l) Magnets shall be designed for operation at 14 volts d.c.

(m) Magnets shall operate satisfactorily when the voltage is reduced 20 per cent below rated voltage.

(n) Rectifier, when specified, shall be furnished by the Manufacturer for mounting in the case.

7. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

8. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

9. *Insulation.*

(a) Wire for coils shall be soft-drawn copper covered with enamel insulation, in accordance with Specification 193, Manual Part 183.

(b) Coils shall be impregnated or otherwise treated so as to satisfactorily protect the wire from moisture under all service conditions.

* Alternate requisites section.

9. *Insulation.*—Continued.

(c) Impregnating compound when used, shall be in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

10. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

11. *Identification.*

(a) Mechanism shall be plainly marked with Manufacturer's references.

(b) Magnet coils shall be plainly marked with Manufacturer's references.

12. *Inspection.*

(a) The material furnished under this specification may be accepted upon Manufacturer's certificates of guarantee insuring that it is in accordance with the specification. If, upon arrival at destination, the material is found not to meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

13. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

14. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

15. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

16. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-6-h.

Mechanism shall be designed to give at least $5\frac{1}{2}$ in. throw of the switch operating rod and shall give complete operation in seconds at lbs. per sq. in. air pressure in bench test with no load on its operating rod.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 248-49.

ELECTRIC SKATE OPERATING MECHANISM

1. *Purpose.*

(a) This specification is for the purpose of providing an electric skate operating mechanism. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Mechanism shall conform to the following drawings or references:

1.
2.

(b) The connection between the skate itself and the skate mechanism shall be such that, with the skate on the rail, the skate can be taken away by the car wheel without damage to the mechanism.

(c) Mechanism shall be so designed as to permit its being held in fixed relation to the rails.

(d) Mechanism shall be enclosed in a substantial metallic weatherproof case, the cover of which shall be removable and equipped with suitable fastenings for application of Purchaser's padlock, and when open shall provide access to all parts.

(e) Mechanism case shall be provided with wire entrance of ample size, conveniently located for access to binding posts,

6. *Design.*—Continued.

equipped with adapter castings and flexible conduit, arranged to protect wires from mechanical injury. *R-6-e.

(f) Moving parts shall work freely, without lost motion, and provision shall be made for lubrication.

(g) Apparatus shall be designed for application to the left-hand rail.

(h) Skate mechanism shall operate in less than 2 seconds.

(i) Contact members shall be made of corrosion-resisting metal of sufficient mechanical strength and current-carrying capacity to satisfactorily operate in connection with the circuits used.

(j) The movement of the contact members shall be such as will insure a wiping contact.

(k) Motor.

1. Motor shall be enclosed in a substantial metallic weatherproof case, the cover of which shall be equipped with suitable fastenings for application of Purchaser's padlock, and when open shall permit access to terminals, commutator and brushes, or their equivalent.

2. The motor shall be capable of delivering, without injury, the torque necessary for the most severe operating conditions.

3. Motor shall be attached to, and form a part of, the mechanism and shall be removable therefrom.

4. Case shall be provided with wire entrance of ample size, conveniently located for access to binding posts, and arranged to protect wires from mechanical injury.

5. Motor shall be designed for:

(a) voltage range d.c.

(b) voltage range cycles a.c.

(l) Bearings.

1. Bearings shall be of ample dimensions to insure reasonable durability.

2. Provision shall be made for proper and convenient lubrication of mechanism.

3. Motor shall be designed to prevent oil from bearings getting on brushes, commutator or windings.

4. Exposed oil holes shall be provided with weatherproof oil cups or covers.

(m) Lubrication.

1. Provision shall be made for convenient lubrication of mechanism.

2. Fittings for pressure lubrication shall be provided.

7. *Wiring.*

(a) Internal wiring shall be neatly arranged and placed in ducts or channels of ample capacity forming an integral part of the apparatus.

* Alternate requisites section.

7. *Wiring.*—Continued.

(b) Wire for internal wiring shall be insulated and of strands of tinned or leaded copper not larger than No. 27 A.W.G. wire. The aggregate cross-section of the strands shall be not less than No. 16 A.W.G. wire. Wire eyelet shall be provided at each end and soldered in, or other suitable terminal provided.

8. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, detail 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or soldered terminals, shall be used where no field wires are connected to such terminals.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

9. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

10. *Coil insulation.*

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(c) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum wall thickness of $\frac{1}{16}$ in.

(d) Insulating material used for fillers in winding coils shall be chemically neutral.

(e) Coils shall be so insulated that they will withstand the insulation test provided in section 11. This test shall be made by mounting coil on a snugly fit metal mandrel and making break-down tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

11. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

(d) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings without any excessive flow of current indicating a short circuit.

12. *Identification.*

(a) Mechanism shall be plainly marked with Manufacturer's references.

(b) Magnet coils shall be plainly marked with Manufacturer's references.

13. *Inspection.*

(a) The material furnished under this specification may be accepted upon Manufacturer's certificates of guarantee insuring that it is in accordance with the specification. If, upon arrival at destination, the material is found not to meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

14. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

15. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

16. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

17. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-6-c.

Mechanism case shall be provided with cable entrance.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 244-49.

ELECTRO-PNEUMATIC SKATE OPERATING MECHANISM

1. *Purpose.*

(a) This specification is for the purpose of providing an electro-pneumatic skate operating mechanism. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *Design.*

(a) Mechanism shall conform to the following drawings or references:

1.
2.

(b) The apparatus shall be so designed that when the magnet valve is energized, the mechanism will place the skate on the rail and when the magnet valve is de-energized, the mechanism will remove the skate from the rail.

(c) The connection between the skate itself and the skate mechanism shall be such that, with the skate on the rail, the skate can be taken away by the car wheel without damage to the mechanism.

(d) Apparatus shall be designed to operate on air pressure between 80 and 105 lbs. per sq. in.

(e) Apparatus shall be so designed as to permit it being held in fixed relation to the rails.

(f) The magnet valve shall be enclosed in a substantial metallic weatherproof case, the cover of which shall be removable and equipped with suitable fastenings for application of Purchaser's padlock, and when open shall provide access to all parts. The case shall be provided with one wire opening for all wires entering the case.

5. *Design.*—Continued.

(g) Moving parts shall work freely, without lost motion, and provision shall be made for lubrication.

(h) Apparatus shall be designed for application to the left-hand rail.

(i) Skate mechanism shall operate in less than 2 seconds.

(j) Pneumatic cylinder.

1. The cylinder shall be attached to, and form a part of, the mechanism, and be removable therefrom.

2. Pipe entrance shall be of ample size and conveniently located for necessary connections.

(k) Air strainer of sufficient size and so constructed as to insure an adequate supply of air free from foreign substance that may interfere with the operation of the valve or cylinder shall be incorporated in the body of the valve and shall be easily removed for cleaning.

(l) Magnet shall be designed for operation at 14 volts d.c.

(m) Magnet shall operate satisfactorily when the voltage is reduced 20 per cent below rated voltage.

(n) Lubrication.

1. Provision shall be made for convenient lubrication of mechanism.

2. Fittings for pressure lubrication shall be provided.

6. *Terminal screws.*

(a) Terminal screws and washers shall conform to Manufacturer's drawings.

(b) Material for terminal screws and washers shall be in accordance with Specifications for Various Types of Non-Ferrous Metals and Alloys, Manual Part 220.

(c) Threaded receptacles for terminal screws shall be mounted so they cannot be turned in the base or frame to which applied, properly insulated.

(d) Terminal screws for external wires shall, as far as practicable, be located adjacent to wire inlet, and duct spaces provided.

7. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

8. *Insulation.*

(a) Wire for coils shall be soft-drawn copper covered with enamel insulation, in accordance with Specification 193, Manual Part 183.

(b) Coils shall be impregnated or otherwise treated so as to satisfactorily protect the wire from moisture under all service conditions.

8. *Insulation.*—Continued.

(c) Impregnating compound when used, shall be in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

9. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) A potential of twice the normal operating requirements at a suitable frequency shall be impressed across the windings without any excessive flow of current indicating a short circuit.

10. *Identification.*

(a) Mechanism shall be plainly marked with Manufacturer's references.

(b) Magnet coils shall be plainly marked with Manufacturer's references.

11. *Inspection.*

(a) The material furnished under this specification may be accepted upon Manufacturer's certificates of guarantee insuring that it is in accordance with the specification. If, upon arrival at destination, the material is found not to meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

12. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

13. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

14. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

15. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of A.A.R. Signal Section Specification 76-45)
A.A.R. SIGNAL SECTION SPECIFICATION 76-49.

ELECTRIC INTERLOCKING MACHINE

Proposed Revision

11. Time releases.

(a) Time releases shall be installed as required by the Purchaser and shall be in accordance with Specification 128, Manual Part 129, where applicable.

(b) Setting of time releases shall be in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128. *R-11-b.

Alternate requisites.

R-11-b.

Setting of time releases shall be

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Section 11 of Specification 76-45—Electric Interlocking Machine,
Manual Part 85.

(Revision of A.A.R. Signal Section Specification 128-44)
A.A.R. SIGNAL SECTION SPECIFICATION 128-49.

MECHANICAL TIME RELEASE

Proposed Revision

1. Purpose.

(a) This specification is for the purpose of providing mechanical apparatus to prevent the operation of an operative unit until after the lapse of a specified time. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Section 1 of Specification 128-44—Mechanical Time Release,
Manual Part 129.

MAXIMUM PERMISSIBLE SPEED, TRAILING THROUGH
CLOSED POINT OF SPRING SWITCH WITH RESPECT
TO (a) BUFFER LIMITATIONS ON NON-FACING
POINT LOCK TYPES AND (b) BUFFER AND
MECHANISM LIMITATIONS ON MECHANICAL
FACING POINT LOCK TYPES

The extensive use of spring switches, together with associated mechanical facing point locks in recent years has focused attention on the speed of trains moving in a trailing direction through the closed points. Furthermore, Requisite 5 of Requisites for Protection for Spring Switches, Manual Part 10, stipulates that special speed restrictions shall be provided for trailing movements through closed points. As a general rule, spring switches are used at locations where the angle of the turnout is the controlling factor with respect to maximum authorized train speeds rather than the spring switch and facing point lock mechanism. However, at certain locations such as the ends of two main tracks where the points are thrown by a train moving on tangent track and at equilateral turnouts, relatively high speeds are possible through the switch in the trailing direction. Therefore, the question arises as to the maximum train speeds at which the spring switch and facing point lock mechanisms will safely operate.

This question received consideration by the Signal Section in 1942 at which time a questionnaire, inquiring as to train speeds at spring switches with and without mechanical facing point locks, was sent to Voting Representatives of Member Roads. A summary of the replies was printed in A.A.R. Signal Section 1942 Proceedings, Vol. XL, p. 107-A. The answers to the questionnaire revealed a divergence of views and practices on the different railroads with respect to speed limitations.

In 1945, Committee II was given an assignment to prepare specifications for spring switch mechanism complete, prescribing maximum permissible speed trailing through closed points at which mechanism will operate reliably, collaborating with A.R.E.A. Committee 5. This assignment was discussed at a number of meetings which were attended by a collaborating member of the A.R.E.A. and representatives of manufacturers. A.R.E.A. Committee 5 gave further consideration to the question and adopted the following report, which was printed in A.R.E.A. 1947 Proceedings, Vol. 48, p. 648:

"Replies to a questionnaire sent members of the Track committee show that there are very few cases where the points are thrown by a train moving on the tangent track and that in such cases the speed is the same as that allowed for a movement through the turnout.

"In most cases the alinement has been changed so that it is not necessary to slow the trains in both directions, the points being thrown when the movement is through the turnout.

"Because of the differences in the types of construction used, including weight of rail, length of points, reinforcing and bracing, and also on account of the differences in classes of power, the committee is of the opinion that a maximum speed cannot be fixed and that each road will have to make its own decision, taking into consideration the type of construction and class of power."

As a result of this action on the part of the A.R.E.A., and on the recommendation of Committee II, the Committees Committee of the Signal Section deleted the reference to train speeds from the assignment in connection with the preparation of a specification for spring switch mechanism.

The current assignment refers specifically to spring switch buffers and mechanical facing point locks without consideration of track structure and fittings. Therefore, in order to obtain present-day views and recommendations of the manufacturers with respect to the maximum train speeds at which the buffers and facing point locks will safely operate, the subject has been further investigated.

One large manufacturer of buffer type spring switch mechanisms states that as a result of actual field observations and theoretical calculations, they do not recommend any speed restriction in connection with their mechanism. Another manufacturer expressed the view that somewhere in the upper speed regions there may be a point where the resistance of the buffer mechanism could introduce stresses in excess of safe limits for proper operation.

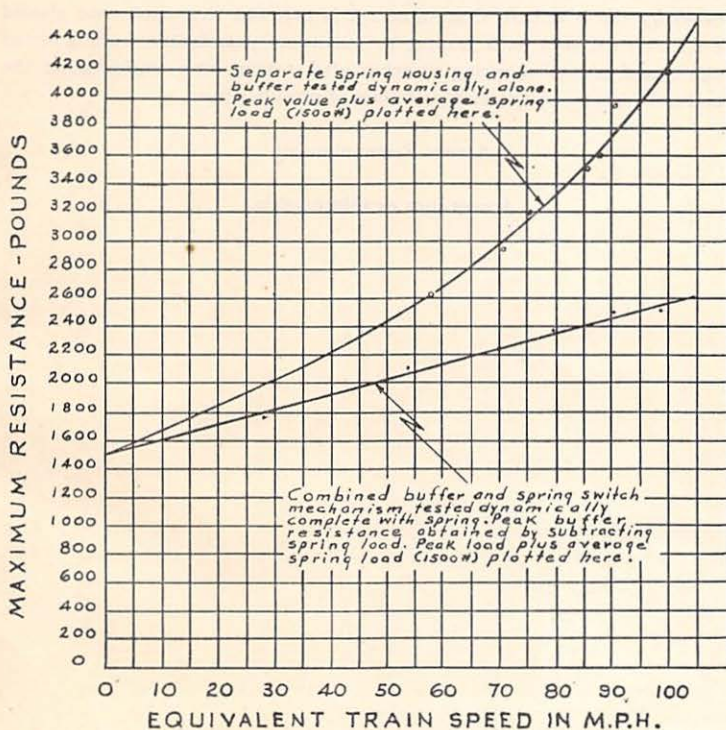
Therefore, to obtain specific information on this point, laboratory tests at room temperature were made on two types of buffer. One is purely a buffer for use with a separate spring housing, and the other combines the buffer and spring in one unit. Both contained oil per Specification 230, Manual Part 236. Using a 7-inch diameter air cylinder to pull out the buffer piston rod at high speeds of the order which occur in service, electric strain gages and other measuring apparatus were employed to obtain oscillograph records of the instantaneous force required to pull the rod at various speeds, giving a continuous record of the force, travel, and time for each test stroke. Curves so obtained had shape determined by the performance of the air cylinder which imposed the pull and therefore do not necessarily have the shape pattern which occurs in service, but the elapsed time in which the piston moved 4 inches was of the same order as in service. For example, field observations of one manufacturer indicate that the No. 1 rod, to which the buffer and spring are attached, does not start to move until the leading wheels are about $9\frac{1}{2}$ feet from this rod, regardless of switch length. Assuming that the rod moves full stroke by the time the wheel is over this rod, this means that the time for 4-inch buffer stroke is of the order of 0.13 second at 50 m.p.h. and 0.065 second at 100 m.p.h. The time for 4-inch piston rod stroke in the laboratory tests ranged from 0.140 to 0.058 second.

A series of tests were made on each of the two buffers, applying different air pressures so as to obtain different piston speeds corresponding to various train speeds. These data were plotted as force versus stroke for each test, and the time for 4-inch stroke noted thereon. On the basis just mentioned, these curves were then rated in terms of equivalent train speed.

To coordinate and evaluate the results for the two types of buffer it was necessary first to take into account the fact that one was without a spring while the other included a spring; and also the fact that buffer resistance being dependent on acceleration and velocity will peak near the middle of the stroke, but the spring force is maximum at the trailed end of the stroke. Actually, the location of the combined spring and buffer peak with respect to the total 4-inch stroke varied from test to test and therefore occurs at various points in the spring compression, but generally speaking occurred mid-stroke. To simplify analysis, the curves for the combination spring and buffer unit were re-

GRAPHICAL CHART SHOWING MAXIMUM INSTANTANEOUS RESISTANCE OF BUFFER AND SPRING TO DISPLACEMENT, OF POINTS WHEN SPRING SWITCH IS TRAILED AT VARIOUS TRAIN SPEEDS.

BUFFERS TESTED IN LABORATORY AT ROOM TEMPERATURE; AND, WITH OIL IN ACCORDANCE WITH A.A.R. SIGNAL SECTION SPECIFICATION 230-47, MANUAL PART 236.



TRAIN SPEED CALCULATED ON BASIS THAT TRAIN TRAVELS 9.5 FEET IN THE TIME TAKEN BY THE PISTON TO MOVE 4 INCHES.

Fig. 1.

drawn with spring effect subtracted; *i.e.*, the curve for static-pull spring force versus stroke position was plotted below each dynamic test curve and subtracted to obtain curve for buffing feature alone. This gave comparable curves for both types of buffers on a "buffing action only" basis. To the peak (*i.e.*, maximum) force for each curve was added 1,500 pounds as the mean spring force during trailing, and this datum plotted against equivalent train speeds. The results are shown in Fig. 1.

Based on the results of laboratory tests, field observations and theoretical calculations in connection with the two common types of buffer mechanisms used on the majority of roads, it appears that trailing speeds through closed points need not be limited in so far as these mechanisms are concerned. In view of field observations and the light mass or weight of the equipment to be moved, it likewise appears that trailing speeds need not be limited in so far as the facing point lock is concerned. However, in accordance with the opinion expressed by the A.R.E.A. Committee, it is believed that each road should make its own decision with respect to maximum permissible trailing speed through closed points of spring switches after taking into consideration the character of switch construction and class of motive power.

Action Recommended

Acceptance as information.

TYPICAL PLANS FOR INTERLOCKED AND
SPRING SWITCH LAYOUTS

Typical plans for interlocked and spring switch layouts based on A.R.E.A. switch plans were prepared with the objective of developing uniform practices that will enable the railroads to meet the prescribed tests and to encourage adoption of A.R.E.A. recommended practice to facilitate production and delivery of switch material and appliances at lower cost by reducing so far as possible the large number of special plans of the individual railroads and manufacturers. The typical plans are as follows:

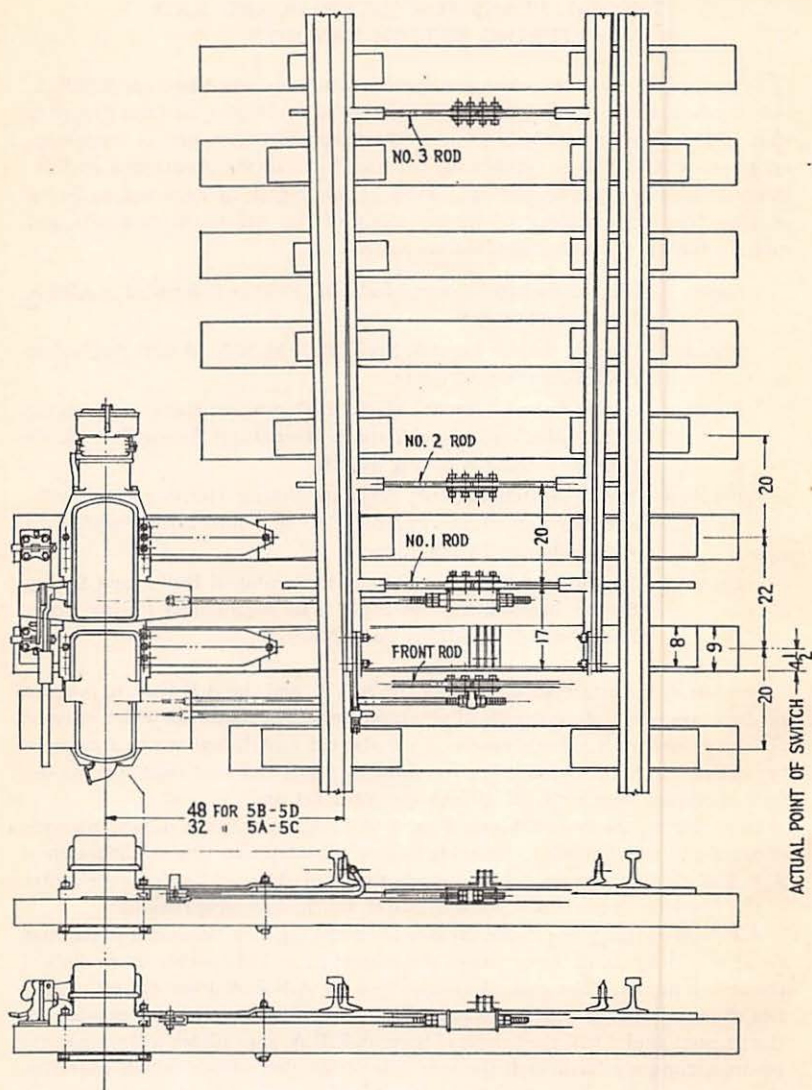
- Figure 1—Electric Switch Layout, Model 5A, B, C or D Applied to AREA Interlocked Switch
- Figure 2—Electric Switch Layout, Style M-2, M-22A, M-22B Applied to AREA Interlocked Switch
- Figure 3—Spring Switch Layout, Model B Combined Buffer and Spring Switch Mechanism and Type A Mechanical Facing Point Lock Applied to AREA Spring Switch
- Figure 4—Spring Switch Layout, Separate Spring Housing and Buffer and Style S-20 Mechanical Facing Point Lock Applied to AREA Spring Switch
- Figure 5—Spring Switch Layout, Model B Combined Buffer and Spring Switch Mechanism and Style S-20 Mechanical Facing Point Lock Applied to AREA Spring Switch

Because of the established policy of the A.A.R. and the A.R.E.A. to prepare no drawings which show details of patented devices or materials which may be obtained only from a single source of supply, the switch layout plans must be typical rather than representing recommended practice and omitting the details of certain front rods, rail braces and other fittings.

In preparing the typical plans, Figs. 1 to 5, inclusive, some difficulties were encountered which made it desirable to give consideration to a modification of A.R.E.A. tie spacing to provide $4\frac{1}{2}$ inches instead of $6\frac{1}{2}$ inches from the center of the No. 1 tie to the actual point of switch for the following reasons:

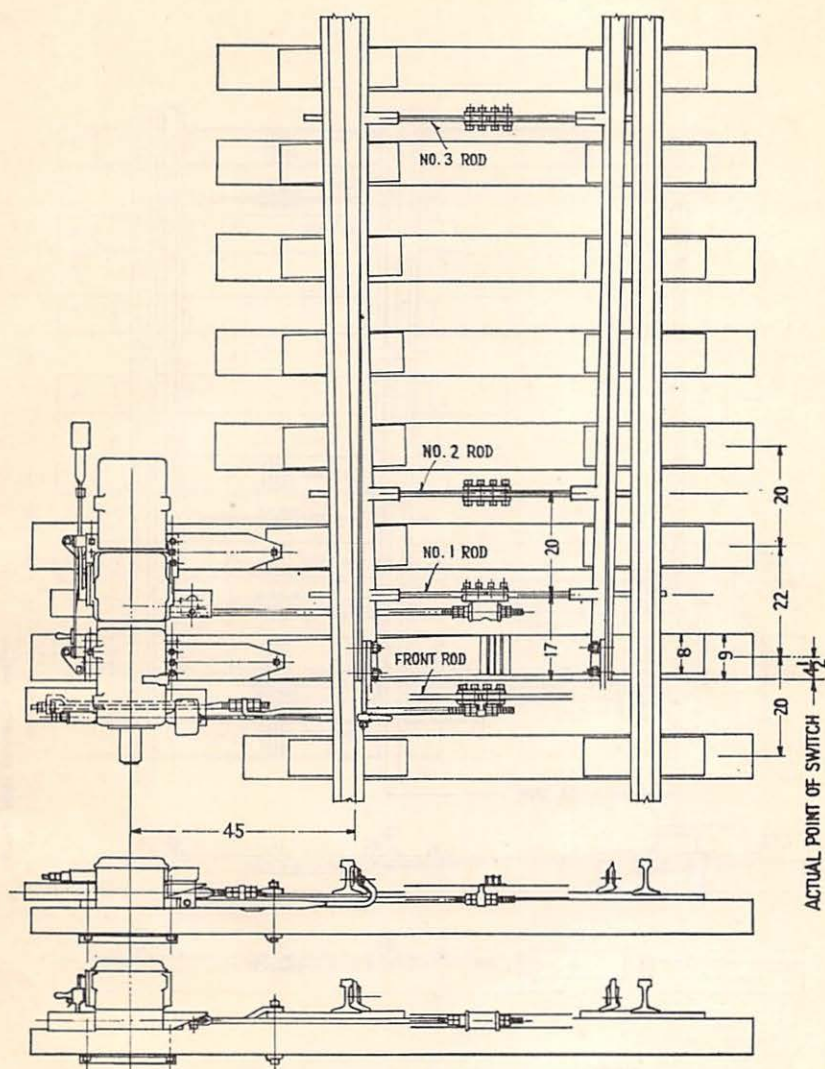
A.R.E.A. switch plans locate the No. 1 rod at 17 inches, the center of the first tie at $6\frac{1}{2}$ inches, and the center of the second tie at $28\frac{1}{2}$ inches, from ends of the switch points. The gage plates specified by A.R.E.A. Plan 224-40 require ties at least 9 inches wide. Because of their bent construction (to provide for the turnout angle) half the length of these A.R.E.A. gage plates will necessarily be approximately flush with the rear side of the ties. With 9-inch wide ties, the distance from center line of the No. 1 rod to rear side of the first tie is 6 inches, and to the rear side of the second tie is 7 inches. In the case of the first tie, the 6-inch distance applies not only to the tie but also to half the gage plate, including its insulated butt joint; thus it is not possible to obtain increased clearance for an adjustment bracket mounted on the front of the No. 1 rod by chamfering the tie.

In studying the typical plans, Figs. 1 to 5, inclusive, the Committee found that several types of switch adjustment brackets used at interlocked switches, and the spring housing for No. 1 rods of the type used with separate oil buffer



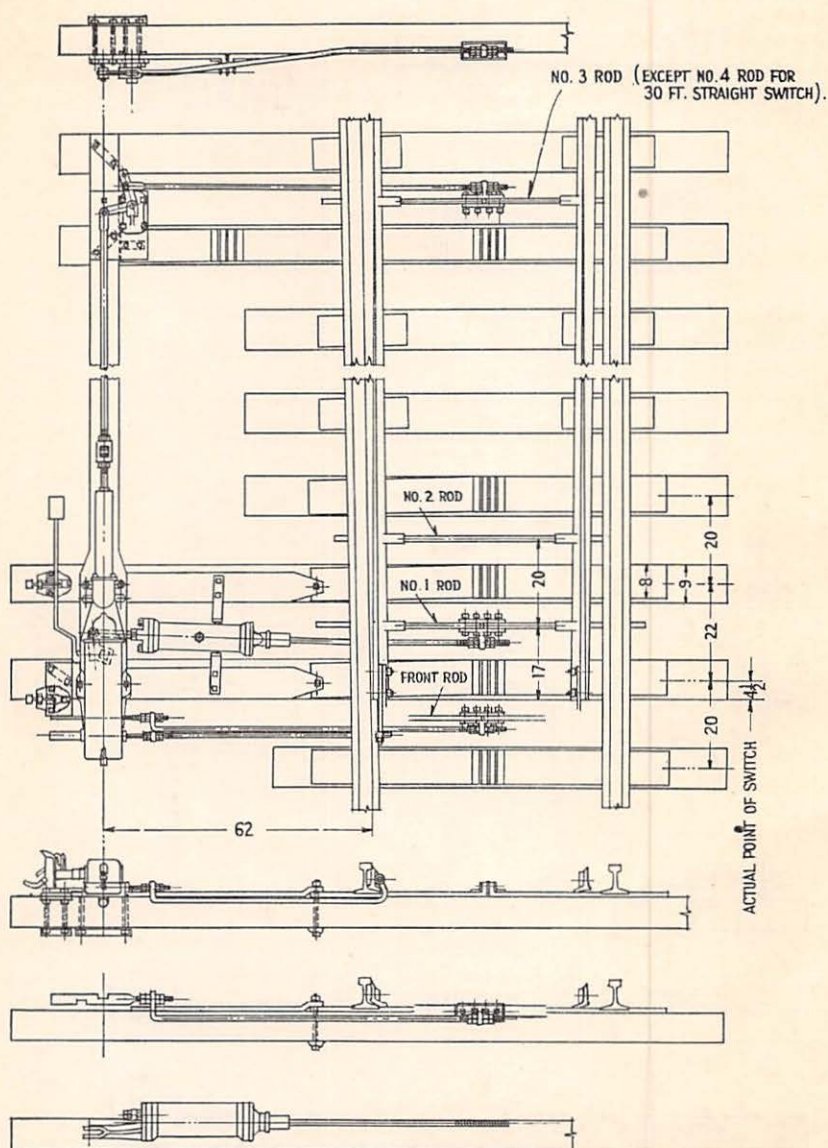
NOTE: ROLLER BEARINGS MAY BE USED WHEN DESIRED.

FIG. 1.



NOTE : ROLLER BEARINGS MAY BE USED WHEN DESIRED.

FIG. 2.



NOTE: ROLLER BEARINGS MAY BE USED WHEN DESIRED.

FIG. 5.

at spring switches, can be applied only to the rear of the No. 1 rod, and not to the front. This is because there are only 6 inches from the center of the No. 1 rod to the near side of the first tie when 9-inch width ties are located where specified by the A.R.E.A. Corresponding space to the rear is 7 inches on the A.R.E.A. switch. With the No. 1 rod located 17 inches from the ends of switch points as specified by the A.R.E.A., a satisfactory layout cannot be obtained with the switch machine connected to adjustment bracket mounted to the rear of the No. 1 rod. By shifting the ties 2 inches ahead, the space ahead of No. 1 rod becomes 8 inches instead of 6 inches, permitting the use of any known type of adjustment bracket ahead of the No. 1 rod. Even when adjustment brackets of the type which permit application to the front of the head rod are used, shifting the ties 2 inches ahead reduces the side set in the operating rod and improves both operating rod and point detector connections with relation to tie clearance in some cases. In no case does it provide a less favorable arrangement, and this statement holds true for all types of front rods in common use.

For spring switches using the Model B combined buffer and spring switch mechanism, this change of tie location, while still permitting application in the usual manner to the end of the No. 1 rod, will also permit the optional arrangement wherein the operating rod is connected to an adjustment bracket in the middle of the No. 1 rod. This optional arrangement has been recommended but is not feasible with the ties located where shown on A.R.E.A. switch plans.

The matter was presented to A.R.E.A. Committee 5—Track at a meeting in Chicago on May 19, 1948, and a motion was passed unanimously that the 17 A.R.E.A. switch plans, basic numbers 111 to 181, inclusive, as applying to interlocked and spring switches, be revised to show the tie spacings beginning at the tie immediately ahead of the switch, 20"-22"-20", the first tie under the switch to be centered $4\frac{1}{2}$ inches back from the point of the switch and with remaining tie spaces adjusted as necessary to provide clearance for existing back rod locations. A letter ballot prepared and submitted to all members of the Track Committee received a favorable vote. The recommended revisions were officially approved at the A.R.E.A. Annual Meeting in Chicago, Ill., on March 17, 1949.

Action Recommended

Acceptance as information.

COMMITTEE III—AUTOMATIC TRAIN CONTROL AND SIGNALS

Personnel

E. S. Taylor, Chairman

J. P. Kaysen, Vice-Chairman

H. D. Abernethy	E. Lockhart
P. P. Ash	J. F. McConahay
R. J. Cullen	C. R. Somers
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J. R. DePriest	A. M. Weeks
D. W. Dower	R. R. Wood
H. C. Griffith	L. C. Heilman*
W. W. Hartzell	D. M. Noell*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Indexing signal literature.
2. Report on Federal, State and Dominion activities on automatic train control, signals, interlocking, highway grade crossing protection, and related safety devices, collaborating with other committees when necessary.
3. Report developments of automatic train control and locomotive cab signals, collaborating with Joint Committee on Train Operation, Control and Signals, A.A.R.

The Committee submits for consideration, reports on the following subjects**:

2. State and Dominion activities.
3. Automatic Train Control and Automatic Cab Signals in the United States as of January 1, 1949.

Hearings set by the Interstate Commerce Commission under the Signal Inspection Act (Docket 28000) for the year 1948.

* Consulting Member.

** Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

- STATE AND DOMINION ACTIVITIES

The following report, which brings the information up-to-date, supersedes report appearing on pages 64 to 90, inclusive, of the 1948 Annual Meeting Advance Notice (A.A.R. Signal Section 1947 Proceedings, Vol. XLV):

Alabama.

Automatic train control:

No law or regulations.

Signals and interlocking:

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Highway grade crossing protection:

No law or regulations of general application in effect.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Arizona.

Automatic train control:

No law or regulations.

Signals and interlocking:

The State Corporation Commission has jurisdiction. Section 69-228, effective 1912, gives the Commission power to determine and prescribe the location, type, installation and maintenance.

Highway grade crossing protection:

The State Corporation Commission has jurisdiction. Section 69-229, effective 1912, gives the Commission power to determine and prescribe the location, type, installation and maintenance.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Arkansas.

Automatic train control:

No law or regulations.

Arkansas—Continued.

Signals and interlocking:

Section 11074 of Pope's Digest provides that railroads must erect, operate and maintain an automatic block signal system at all tunnels, said block signals to be located at least 2,500 feet from each end of the tunnel.

Highway grade crossing protection:

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

Section 11072 of Pope's Digest provides that railroads shall be required to place and maintain sufficient lights during the nighttime on all its main track switches, and of the color green indicating switch lined for main track movement and the color red to indicate switch lined for side track movement.

1947, Title 73, Section 711, covers requirements for lights to be placed on switches both main line and side tracks. No authority for substitution of reflecting devices.

California.

Automatic train control:

No law or regulations.

Signals and interlocking:

General Order 33 (b), March 16, 1936, issued by the Public Utilities Commission, establishes certain requisites for the installation of interlocking. Requires submission of plans for new installations and changes in existing plants.

Highway grade crossing protection:

General Order 75-B, July 17, 1939, issued by the Public Utilities Commission, covers regulations governing protection of crossing at grade of roads, highways and streets with railroads. This Order specifies certain types of signals, stipulates warning aspects shall be displayed for approximately 25 seconds, with limits of from 20 to 30 seconds, in advance of the normally fastest train operated over the crossing protected. Provides for approval covering removal, reduction or substitution of protection.

Chapter No. 1489, Statutes of 1947, amends the Vehicular Code to authorize erection of "Stop" signs under certain conditions where highways and streets cross railroads at grade.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Colorado.

Automatic train control:

No law or regulations.

Signals and interlocking:

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Highway grade crossing protection:

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railways for such projects. Reflectorized approach railroad warning signs at grade crossings are furnished, installed and maintained by the local authorities. On Federal Aid Crossing projects, the railroad furnishes and installs the signs, but the items are reimbursable from the participating funds and the contract for each individual project specifically mentions this feature; also the contract provides that maintenance and repair of such signs, is to be the responsibility of either the State, county or city.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Connecticut.

Automatic train control:

No law or regulations.

Signals and interlocking:

Sec. 1414 c (1935). The Public Utilities Commission may order reasonable improvements, repairs or alterations in plant or equipment or changes in manner of operation as may reasonably be necessary in the Public interest.

Sec. 5536 (1949). No Railroad Company shall change the character of its system or signals either as to color or otherwise without written approval of the Commission.

Sec. 3745 (1930). The Commission may permit passenger trains to run past any switch, station or highway crossing at such rate of speed as it may prescribe upon provision by the Railroad Company of such safeguards as the Commission may require.

Sec. 3742 (1930). Trains shall be brought to a full stop not less than 200', nor more than 800' from a drawbridge or a railroad crossing at grade unless the Commission authorizes in writing such passing without stopping when in its opinion such can be done consistent with public safety.

Highway grade crossing protection:

Sec. 5541 (1949). Of its own motion, or upon petition by Towns, Cities, or Boroughs to order gates, a flagman, electric signals or other signal device the Commission may, after holding a Public Hearing, order a Railroad Com-

Connecticut—Continued.

pany to install and maintain at a Highway Grade Crossing, gates, a flagman, electric signals or other signal device as may be deemed necessary for the protection of the public.

Sec. 5542 (1949). Towns, Cities and Boroughs shall place and maintain the prescribed type of approach warning signs not less than 300' nor more than 500' from the nearest rail of grade crossing. Such signs shall be furnished by the Railroad Company crossing the highway. The Commission may release municipalities from this obligation when such signs are impracticable or unnecessary.

Sec. 5545 (1949). Railroad Company shall maintain at each crossing where there is no gate, warning boards of the approved type.

This State participates in Federal allotments for protection at highway grade crossings. Under certain conditions the Railroad Company may be obliged to participate to the extent of 10 per cent of the cost.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Delaware:

Automatic train control:

No law or regulations.

Signals and interlocking:

There is no regulation of installation, maintenance or inspection of railway signaling conferred by State statutes.

Practice is generally in accordance with Interstate Commerce Commission Rules, Standards and Instructions, effective September 1, 1939.

Highway grade crossing protection:

No State law or regulation of general application in effect.

A.A.R. standard flashing light signals have been installed without question.

The Revised Code of Delaware, 1935, embodies some requirements for the provision of electric gong signals, watchmen, "Railroad Crossing" signs, etc., at certain specified crossing locations.

Section 2180 of the Code requires any railroad company, incorporated under Delaware laws, to maintain a safety gate or flagman at any crossing within a city or incorporated town, when notified to do so by the city or town authorities.

Where the State desires to provide and have installed automatic highway grade crossing protection, Delaware participates in Federal fund allotments, allocated to the State under provisions of the "Federal-Aid Highway Act of 1944," approved December 20, 1944, and reimburses the railroads for such projects. The amount of reimbursement is established by agreement covering the individual installation.

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Com. III—Auto. Train Control and Signals

Delaware—Continued.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Florida.

Automatic train control:

No law or regulations.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Georgia.

Automatic train control:

No law or regulations.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Idaho.

Automatic train control:

See under Signals and interlocking.

Signals and interlocking:

According to I.C.A. 1932, Sec. 59-515, safety regulations—"The Public Utilities Commission of Idaho shall have the power, after a hearing had upon its own motion or upon complaint, by general or special orders, or regulations, or otherwise, to require every public utility to maintain and operate

Idaho—Continued.

its line, plant, system, equipment, apparatus, tracks and premises in such manner as to promote and safeguard the health and safety of its employees, passengers, customers and the public, and to this end to prescribe, among other things, the installation, use, maintenance and operation of appropriate safety or other devices or appliances, including interlocking and other protective devices at grade crossings or junction and block or other systems of signaling, to establish uniform or other standards of equipment, and to require the performance of any other act which the health or safety of its employees, passengers, customers, or the public may demand."

Highway grade crossing protection:

Upon complaint signed by any taxpayer and also signed by any county commissioner, Commission may hold a hearing and require protection of highway crossing by gates, flagmen, or electric signal or other suitable device (I.C.A. Sec. 59-516).

All railroad-highway crossing signs must be reflectorized.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Illinois.

Automatic train control:

No law or regulations.

Signals and interlocking:

Ch. 111 2/3 No. 61 (). The Illinois Commerce Commission is granted the power to regulate public utilities and can require railroad to install, maintain and operate interlockings, automatic signals and other safety devices.

No. 62 () provides that no railroad track may be constructed across the track of another railroad at grade without approval of Commission who shall have the power to prescribe the manner, including the particular point of crossing, and the terms of installation, operation, maintenance, use and protection for each grade crossing.

Ch. 114 No. 68 (Supp.) (1943) requires the railroads to submit plans of proposed interlockings for railroad crossings at grade to the Commission for approval. Also may order discontinuance of any interlocking which it declares unsafe.

No. 69 (1943). Commission may appoint engineers to examine plans of interlockings and assess cost against railroad.

Nos. 133, 134 and 135 (1943) provide that where two or more railroads cross at grade, one railroad may petition Commission to order such crossing protected by interlocking. Commission may, on its own motion, order railroads to protect grade crossings, where hearing determines that public safety requires it. If railroads cannot agree, the Commission may

Illinois—Continued.

specify type of interlocking and proportion of expense of installation, maintenance and operation among the various railroads involved.

General Order 6, issued by Illinois Commerce Commission, effective January 1, 1914, prescribes Rules Governing the Construction, Maintenance and Operation of Interlocking Plants.

Highway grade crossing protection:

Ch. 111 2/3 No. 62 () provides that no public road, highway or street shall be constructed across any railroad at grade, nor any railroad across a public road, highway or street, without approval of the Commission who shall have the power to prescribe the manner, including the particular point of crossing, and the terms of installation, operation, maintenance, use and protection of each grade crossing.

Also provides the Commission shall have authority to designate grade crossings which are extra hazardous and at such grade crossings shall have the power to require protective devices and also to determine the division of expense for such protective devices between the railroad and the State or its political subdivisions.

Ch. 114 No. 58 () requires that railroads install and maintain crossing signs at all highway-railroad grade crossings, not within corporate limits of cities, towns or villages. Within corporate limits, authorities of cities, towns or villages shall have jurisdiction.

The Illinois Commerce Commission issued General Order 138, adopted July 27, 1937, "Rules, Regulations and Requirements relating to the Construction, Maintenance, Marking and Protection of Crossings of Highways and Railroads in State of Illinois."

The Commission, as of March 30, 1941, supplemented General Order No. 138 with "Specifications for Railroad Highway Grade Crossing Protection."

This State participates in Federal allotments for protection at highway grade crossings.

Railroad pays 10 per cent of cost within estimate, but all in excess of estimate.

Related safety devices:

No State law.

Reflecting devices as a substitute for oil or electric lights:

Illinois Commerce Commission Order No. 155, dated October 29, 1944, states that "on and after the date of service of this order, no steam or electric railroad in the State of Illinois shall make any change in switch lamps on main track switch stands of the nature set forth in finding (3) of this order unless and until this Commission shall by order grant its permission to make such change; where any railroad company proposes to make such a change it shall file with this Commission a duly verified petition setting forth in reasonable detail the nature of the change proposed to be made, the reasons in support thereof, and where appropriate a plan showing the location of the proposed change and the tracks in the vicinity thereof."

Indiana.

Automatic train control:

No law or regulations.

Signals and interlocking:

55-101 (q) provides that The Public Service Commission shall have power to require railroads to install, maintain and operate an approved interlocking and derailing device at railroad crossings, swing or drawbridges.

55-101 (r) provides that the Commission may order any interlocking discontinued if it determines that life and property will be best secured thereby.

55-101 (s) provides that the Commission, upon application by railroads, authorize substitution of devices for those which previously have been required.

55-626 provides that with an approved system of interlocking trains may operate over railroad crossings and drawbridges without stopping.

55-1254 provides that after January 1912, it shall be unlawful for a railroad to operate a train or car over its line that is not equipped and in operation with an automatic block system or other system approved by Railroad Commission of Indiana. Time may be extended by Commission.

55-1255 provides that the Commission may extend the time as specified in 55-1254 when a reasonable necessity exists. Commission may relieve any railroad of this requirement if the volume of traffic, or train or car movement is such that it can be handled without substantial hazard to life or property. Commission may require other systems such as controlled manual block, or manual block, or other form of block, or other signaling systems.

The Public Service Commission of Indiana, under Act of State Legislature issued as of February 1, 1915, prescribes rules and regulations for: the installation and maintenance of interlockings. At a session of the Commission, Case 15785, approved February 19, 1943, the rules and regulations contained in this Act were rescinded and the Commission adopted the rules and regulations issued by the Interstate Commerce Commission under the Signal Inspection Act. The Commission requires copies of applications to the I.C.C., copy of the Notice of Approval by the I.C.C., also Notification of the Completion of the Project; the Commission retaining power to make periodic inspections of all interlockings within its jurisdiction.

Highway grade crossing protection:

Chapter 49 (1915). The Public Service Commission of Indiana has the power under the Act of the State Legislature to require protection for highways at crossings with railroads and also the power to condemn and remove obstructions to the view of such crossings.

Sec. 55-2012 (1931) (Amended). Commission upon proper petition and hearing, may declare railroad-highway grade crossing extra hazardous, requiring additional protection for highway users.

Sec. 55-2014 (1931) (Amended). The installation of additional protection at grade crossings declared extra hazardous shall be paid for as follows: (1) If installed in city or town having more than 700 population (last U.S. census) the cost shall be divided equally between city or town and the railroad. (2) If installed in city or town having less than 700 population (last U.S. census)

Indiana—Continued.

the cost shall be divided equally between railroad and State Highway Commission.

Sec. 55-2015 (1931) (Amended). After installation of safety devices maintenance costs shall be borne by railroad, except that costs of repairs and renewals shall be divided in accordance with original installation.

Sec. 55-2020 provides common councils of cities of Indiana shall have power to require railroads to keep and maintain lights, as specified by council, at all intersections of streets and railroads.

This State participates in Federal allotments for protection at highway grade crossings.

Railroad pays 10 per cent of cost within estimate, but all in excess of estimate.

Related safety devices:

Sec. 55-1248 requires each switch connected with main track to be equipped with a switch light attached to and operated by movement of switch. Light to be left burning constantly between hours of sunset and sunrise and when dark and foggy.

Sec. 55-1249 requires each derail, except when interlocked, to be provided with a switch light attached to and operated by movement of derail. Light shall be kept burning constantly between hours of sunset and sunrise and when dark and foggy.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Iowa.

Automatic train control:

No law or regulations.

Signals and interlocking:

478.30 (1913) provides that at points where the tracks of an interurban railway cross the tracks of a steam railway at grade, the steam railway shall, except when required to stop by order of the Iowa State Commerce Commission, have the right-of-way and not be compelled to stop its trains; and that the interurban railway shall stop its trains not nearer than 10 feet nor more than 50 feet from such crossing; and outlines the manner in which the interurban railway shall protect its movement over the crossing.

478.31 (1897) provides that trains of steam railroads must come to a full stop at a distance of not less than 200 feet nor more than 800 feet from the point of intersection or crossing before such intersection or crossing is reached, unless interlocking or other suitable device is provided and is approved by the Commerce Commission.

478.33 (1897) provides for the establishment of interlocking or other safety device at railroad grade crossings; the submission of plans to the Commerce Commission for approval; for inspection after completion; and for the issuance of a certificate of approval.

478.34 (1925) provides for approval by the Commerce Commission of changes in the construction, arrangement or location of an interlocking

Iowa—Continued.

system or other safety device; and for the furnishing of plans and their approval; for inspection and for the issuance of approval.

478.35 (1924) provides that an interlocking system or other safety device found unsafe or dangerous may be condemned and that railroads may be required to provide acceptable safe protection.

478.36 (1924) provides that where deemed necessary for the public safety railroads may be required to establish an interlocking system or other safety device at any railroad crossing, junction or drawbridge.

Under the provisions of the above sections of the Iowa statutes rules pertaining to interlockings were originally adopted February 2, 1914. These rules were cancelled August 15, 1942, at which time new rules were adopted by the Commerce Commission. Principal provisions are as follows:

- (a) Plans covering new installations and changes in existing facilities must be submitted to the Commerce Commission for approval.
- (b) Following the installation of new work or major changes interlockings must be placed in conditional service for not less than twenty-four hours or until released by the Commerce Commission. After inspection, certificate will be issued if the plant is found to be satisfactory.
- (c) Requisites for interlocking plants and other safety devices are identical to those adopted by the Interstate Commerce Commission September 1, 1939.
- (d) Quarterly inspection reports for each interlocking or other safety device must be filed with the Commerce Commission by the maintaining railroad.

474.11 (1939) provides that the Commerce Commission may require the removal or alteration of any lights on public or private property, erected for illuminating purposes, when such lights interfere with the easy observation of railroad signals by those engaged in the operation of trains.

Highway grade crossing protection:

389.41 (1897) provides that cities and towns shall have power to require railroads to provide crossing protection; provided, however, that in case of controversy as to the necessity for such protection, the matter shall be determined by the Iowa State Commerce Commission.

478.21 (1947) provides that wherever a railroad track crosses or shall hereafter cross a highway, street or alley, the highway authorities and the railroad may agree upon the location and manner of crossing, or upon a separation of grades, and upon any change, alteration, vacation or relocation of the highway, and upon repairs, alteration or elimination of any crossing and upon the expense each party shall pay.

478.22 (1915) provides that where agreement cannot be reached between parties concerned in 478.21 that written application may be made to the Commerce Commission, whereupon the Commission shall give notice and fix a date for hearing.

478.23 (1915) provides for determination of matters involved in 478.21 and 478.22 including the division of expense between the parties.

Under the provisions of the general statutes of the State of Iowa relating to the regulation of railroads, the Commerce Commission, after hearings and

Iowa—Continued.

decisions rendered December 28, 1934 and April 23, 1938, adopted requisites for highway-railroad grade crossings, effective February 15, 1935 and last revised August 23, 1938. Recognized standards of protection are as follows:

- (a) Flashing light signals, back to back; flashing light signals with rotating stop signs; flashing light signals with automatic gate arms; wig-wag type signals.
- (b) Plans covering new installations or changes in protection must be submitted for approval. After completion, inspection is made and if installation or changes are found satisfactory, a certificate of approval is issued.
- (c) Detailed requirements are generally similar to those contained in Bulletin No. 3 of the Joint Committee on Grade Crossing Protection of the A.A.R.
- (d) All tracks over crossings must be provided with track circuits.
- (e) Signals shall display most restrictive indication provided any part of crossing is occupied and if there is a failure of any part of the circuit.
- (f) Bells may be used in conjunction with signals where local conditions warrant.

This State participates in Federal allotments for protection at highway grade crossings.

Related safety devices:

Advance warning signs on highways approaching railroad grade crossings are installed and maintained by highway authorities. Signs on primary highways are installed and maintained by the State Highway Commission pursuant to Section 321.253. On other highways the signs are under the jurisdiction of the local highway authorities as provided by Section 321.255.

Reflecting devices as a substitute for oil and electric lights:

No law or regulations.

Kansas.

Automatic train control:

No law or regulations.

Signals and interlocking:

Sections 66-162 and 66-163 GS provide the procedure by which when two or more railroads cross at common grade, interlocking devices, automatic signals, or other works or fixtures rendering it safe for engines or trains to pass over the crossing without stopping, may be required and installed under supervision of the State Commission.

Highway grade crossing protection:

Section 68-414 GS provides that when the State Highway Commission deems it advisable, said railroad company may be required by order of the State Highway Commission to install and maintain suitable safety devices or warning signals at dangerous or obscure crossings to indicate the approach of trains.

Kansas—Continued.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Reflecting devices as a substitute for oil or electric lights:

Section 66-2-108 GS Switch Lights. "It shall be the duty of any person, firm or corporation or receiver, owning or operating any railroad, in whole or in part, in the State of Kansas, to equip and maintain in good condition, switch lights on all main line switch stands, except where automatic block signals are used and where such automatic block signals are so located as to answer the purpose of switch lights, and to keep all lights controlling the movements of trains on the main line burning from sunset to sunrise: *Provided*, This act shall not apply to branch lines, where trains are not regularly operated at night, or in cases where the lights have been properly lit, but have failed for causes beyond the control of the company, and it has not had reasonable time to relight them."

Section 66-2-109 Same: penalty. "That any person, firm or corporation or receiver owning or operating any railroad in whole or in part in the State of Kansas, violating any provision of this act shall be deemed guilty of a misdemeanor and fined in the sum of not less than one hundred dollars nor more than five hundred dollars, for each offense."

Kentucky.

Automatic train control:

No law or regulations.

Signals and interlocking:

Section 277.180 of the Kentucky Statutes provides that whenever railroad lines cross each other in this State each train shall be brought to a full stop at least 50 feet before it reaches the crossing, unless the crossing is regulated by a derailing switch or other safety appliance that prevents collision at crossings, or a flagman or watchman is stationed at the crossing and signals that the train may cross in safety.

Highway grade crossing protection:

Section 277.160 requires that railroads shall erect and maintain at every public highway crossing signs bearing the words "Railroad Crossing." Such signs need not be erected within cities unless required by local ordinances.

Section 277.170 empowers the Railroad Commission to require a railroad to provide gates or flagmen at crossings which the Commission considers to be particularly dangerous. The type of protection and the hours of operation may be specified by the Commission.

In addition to the above, municipalities of the first, second, third or fourth class are given the power by statute to prescribe the character of protection which shall be provided at grade crossings within their boundaries.

Furthermore, where a crossing is unusually dangerous, Kentucky courts hold that it is the duty of railroad companies to provide such additional warnings as are necessary to give notice of the approach of trains.

Kentucky—Continued.

Kentucky participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Louisiana.

Automatic train control:

No law or regulations.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

No law or regulations.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

All railroads in the State of Louisiana, where night trains are scheduled, are required to maintain and keep lighted during the hours between sunset and sunrise, switch lights on all main track, yard and terminal switches, and at such other points as may be deemed reasonable and necessary.

Maine.

Automatic train control:

No law or regulations.

Signals and interlocking:

Chapter 42, Sec. 85, Revised Statutes of Maine, provides that the Public Utilities Commission may, after due notice and hearing, authorize an interlocking at railroad grade crossings. When such interlocking is installed and approved, trains shall not be required to stop and protect their movements over the crossing.

Highway grade crossing protection:

Chapter 42, Sec. 88, Revised Statutes of Maine, provides that the Public Utilities Commission may, after reasonable notice and hearing, require a railroad to provide automatic signals, gates, flagmen or other protection at such crossings as required in the interest of public safety.

Maine participates in the Federal allotments for protection of highway grade crossings and reimburses the railroads for such projects.

Maine—Continued.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

Railroads having express trains running after dark required to provide switch lights unless relieved of this requirement by Public Utility Commission.

Maryland.

Automatic train control:

No law or regulations.

Signals and interlocking:

Permits crossing of tracks of one railroad by tracks of another railroad, either by agreement or condemnation of easement, provided that the crossing road shall, at its own expense, "erect a proper signal station" **** "and keep a watchman thereat."

Article 23, Sec. 245, 1939 Annotated Code of Maryland State Laws. (First issue Ann. Code 1886, Ch. 107.)

Other than the foregoing there are no State, or Public Service Commission rules or regulations in Maryland governing the nature of protection, such as signals, derails, stops, etc., at railroad grade crossings.

Practice is generally in accordance with Interstate Commerce Commission Rules, Standards and Instructions, effective September 1, 1939.

Highway grade crossing protection:

Whenever a railroad crosses any public highway at grade outside corporate limits of cities, and such crossing shall be believed to be dangerous, it is the duty of the county commissioners, after notifying the railroad, to consider the necessity for protection, and if necessary they may order the railroad to install within sixty days, a flagman, and system of electric alarm bells, or safety gates which shall be closed not less than one-half minute before the passage and during the passage of every railroad train or locomotive across said highway.

Article 23, Sec. 242, 1939 Annotated Code of Maryland State Laws. (First issue Ann. Code 1886, Ch. 294, Sec. 1.)

A.A.R. standard flashing light signals have been installed with approval of the County Commissioners.

Maryland participates in Federal funds allocated to the State under provisions of the "Federal-Aid Highway Act of 1944," approved December 20, 1944, and reimburses the railroads for such projects. The amount of reimbursement is established by agreement covering the individual installation, as between the railroad and the State Roads Commission, by authority of Section 48 of Article 89B of the Maryland Code 1939 Edition. See also Article 89B, Sections 30-49A Annotated Code of Maryland, 1947 Cumulative Supplement.

Related safety devices:

No law or regulations.

Maryland—Continued.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Massachusetts.

Automatic train control:

No law or regulations.

Signals and interlocking:

Chapter 159, No. 22. The Department of Public Utility may from time to time require railroad and railway corporations to install and maintain at such places upon the railroad or railway premises as it shall designate such block or other signals or devices as it shall approve for the purpose of safeguarding public travel.

Chapter 160, No. 136. The Department shall make general regulations for all such crossings or special regulations for such particular crossing as it may designate, and in such detail as it may consider expedient; and the supreme judicial court may issue any processes necessary to secure the enforcement of such regulations, or, upon the petition of the department, may enjoin the running of trains on a railroad upon which any regulation relative to such crossing is not exactly observed. The approval of the department shall be required for a system of signals to be established and maintained in concert by corporations operating railroads which cross each other; but no such regulation or system of signals shall exempt a railroad upon or across which passenger trains are run from the requirements of the preceding section, unless a system of interlocking or automatic signals, approved in writing by the department, is adopted by both corporations.

Chapter 160, No. 137. The department may, on the application of a railroad corporation whose railroad crosses another railroad at the same level, after notice to the parties and a hearing, authorize the applicant at its own expense, to establish and maintain the necessary wires, rods, signal posts and signals, in such manner as the department shall prescribe. Such corporation, after the system has been established and approved in writing by the department, shall be exempt as to such crossing from the requirements of section one hundred and thirty-five so long as the department continues its approval. Upon payment to such corporation by the corporation owning or operating the other railroad at such crossing of so much of the cost of establishing such system of signals, as, upon petition of the latter corporation and a hearing, is awarded by the department, both railroad corporations shall, as to that crossing, be exempted from the requirements of said section. Until such payment the latter corporation shall semi-annually contribute toward the expense of operating said signals an amount equal to the cost to it of operating the signals used by it at said crossing before the establishment of the signals herein provided for. After the payment of such award, the expense of maintaining and operating such system of signals shall be borne by the two railroad corporations according to the proportions fixed by the award for paying the original cost of the signals. So much of the award as relates to the cost of maintaining and operating said signals may, at the request of either party, be revised at the expiration of five years from the original award or from any revision thereof.

Massachusetts—Continued.

Highway grade crossing protection:

Chapter 160, No. 147. The department, after notice to a railroad corporation whose railroad crosses a public way or traveled place at the same level, and a hearing, may direct in writing that gates shall be erected at said crossing across said way or place and that an agent be stationed thereat to open and close such gates when an engine or train passes, or that a flagman be stationed at the crossing, who shall display a flag when an engine or train passes, or that such crossing shall be provided with such an electric sign as the department determines the better security of human life or the convenience of public travel requires, and the corporation shall comply with such order.

Chapter 160, No. 147. The cost of installing, maintaining and operating such protection shall be borne by the railroad, except that a City or Town may, by agreement subject to the approval of the department, contribute to the cost thereof, and the department of public works, if the crossing and its approaches are in direct continuation or a part of a State highway, may, by agreement subject to like approval, contribute toward the cost thereof in behalf of the commonwealth.

This State participates in Federal allotments for protection at highway grade crossings.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Michigan.

Automatic train control:

No law or regulations.

Signals and interlocking:

No specific regulations covering installation and maintenance.

Details of signal and interlocking installations at crossings at grade, junctions and drawbridges may be prescribed if deemed advisable. Plans must be submitted for approval. Costs can be apportioned by Commission on an equitable basis among the companies involved. (Sec. 36, Act 300, 1909, p. 704. Eff. Sept. 1, 1909. See also Sec. 11052, page 3882, Compiled Laws of 1929.)

A signal light must be maintained from sunset to sunrise on each switch connected with the railroad's main track, and on each derail switch and device, except upon derails connected with the home signal at interlockers or derailing devices on tracks used exclusively for private purposes. Unless ordered by the Commission, requirements do not apply to tracks used for private purposes, to short lines of 100 miles or under, to spurs or side lines or railroads on which night trains are not operated. Sections 1 and 2, Act 189, 1921, page 375, Eff. August 18, 1921. See also Sections 11426 and 11427, page 4064, Compiled Laws of 1929.

The Commission may prescribe safeguards at grade crossings on railroads or street railway tracks with other railroad or street railway tracks and may apportion installation cost and any other expenses incident thereto between the railroads or street railways affected. Sections 3 and 5, Act 171, 1893,

Michigan—Continued.

page 270, Eff. August 28, 1893. See also Sections 11416 and 11418, page 4061, Compiled Laws of 1929. As applicable to railroads incorporated in Michigan under Act 198, 1873, page 496, Eff. May 1, 1873, see Section 7 of Article II thereof. See also Section 11119, page 3910, Compiled Laws of 1929.

Requires every locomotive, engine, passenger, freight and other trains to stop not nearer than 200 feet, or farther than 800 feet, from any railroad crossing which is not protected by an interlocking switch and signal system approved by the Commission for operation without stoppage. Sec. 14, Act 174, 1883, Eff. Sept. 8, 1883. See also Section 11182, page 3954, Compiled Laws of 1929.

Practice is generally in accordance with Interstate Commission Rules, Standards and Instructions, effective Sept. 1, 1939.

Highway grade crossing protection:

Reflector type crossbucks with Number of Tracks signs must be provided by highway authorities on all country crossings and on all State trunk and county highway crossings in cities and villages, with initial expense to be shared equally with railroad and subsequent expense to be borne solely by highway authorities. Section 5, Act 270, 1921, page 501, Eff. May 18, 1921, as amended by Act 336, 1931, page 801, Eff. September 18, 1931. See also Section 11406, page 1161, 1940, Supplement to Compiled Laws of 1929.

Commission may prescribe flashing light signals at railroad crossings, with gong at each signal, with reflector type crossbucks. Number of Track signs, and Stop on Red Signal signs, under statutory specifications. Commission may require a minimum of twenty seconds and a maximum of sixty seconds operating in advance of train movements reaching the crossing. Installation, alteration or relocation cost is borne equally by railroad and highway authorities, but railroad must maintain at its expense, except that highway authorities pay \$10 per month to railroad for each such protected crossing. Voluntary installations are at expense of the railroad. Section 8, Act 270, page 501, Eff. May 18, 1931, as amended by Section 336, 1931, page 801, Eff. September 18, 1931. See also Section 11409, page 1161, 1940 Supplement to Compiled Laws of 1929.

In order to forego the \$10 monthly payment, by contract the installation is frequently made at the sole expense of the highway authorities, the railroad assuming the \$10 monthly payment for maintenance.

Where an intersection of highways and railroad requires four flashers instead of the normal two, the Highway Department should pay \$20 to the railroad instead of \$10. Opinion of Attorney General, January 9, 1932, Footnote to Section 11409, 1940 supplement to Compiled Laws of 1929.

The Commission is authorized by statute to require the construction and maintenance of gates and to require the maintenance of a gate-keeper at every highway or street crossing, the expense of which is to be shared equally by the railroads affected. The Commission takes the position that under the Statute it has the authority to approve the installation of half-roadway gates when used in connection with flashing light signals. However, it appears doubtful if the Statutory requirements are satisfied unless the gates, when closed, are such as to prevent any passage across the tracks from the side on

Michigan—Continued.

which the gate is located. Sections 2 and 4, Act 198, 1873, page 496, Eff. May 1, 1873. See also Sections 11170 and 11172, page 3949, Compiled Laws of 1929.

Commission's permission must be obtained to cross existing railroad track with new highway and Commission may prescribe protection at the crossing, with railroad to construct and maintain, but highway authorities to furnish labor and material and to reimburse for actual and necessary expense of maintenance, value of use of the railroad's land so used, and \$5.00 per day for railroad employee superintending construction. Section 27, Chapter I, Act 283, 1909, page 544, Eff. September 1, 1909. See also Section 3943, page 1574, Compiled Laws of 1929.

Certain cities may compel railroad to construct street crossings with such protection to highway users as city may require, and to compel railroad to maintain flagmen or watchmen at all crossings of streets, to give warning of approaching trains, and to light such crossings at night. Section 6, Chapter XI, Act 215, 1895, page 389, Eff. August 30, 1895. See also Section 1950, page 884, Compiled Laws of 1929 (possibly repealed by implication in Act 336, 1931, above).

Commission may order railroad to provide suitable safeguards, substantially as provided for highway and street crossings, where the railroad track intervenes between the highway and a residential building fronting on the highway. Section 15, Article IV, Act 198, 1873, page 496, Eff. May 1, 1873. See also Section 11183, Compiled Laws, page 3955, Compiled Laws, 1929.

In case of failure of mechanical or electrical signal protection at highway crossings of railroads, the company operating the railroad, shall, as soon as possible, station a crossing watchman to warn highway traffic until such signals are restored to working order.

Commission will from time to time issue approved plans and specifications as conditions may require with respect to construction of highway crossing signals.

Michigan Public Service Commission Administrative Code, Rule No. 3, Rules and Regulations in Michigan, issued by order of the Commission effective Jan. 1, 1944.

Michigan participates in Federal allotments for highway crossings under provisions of the Federal-Aid Highway Act of 1944, and reimburses the railroads for such projects. The State of Michigan, by Act 99, 1917, page 178, Eff. April 25, 1917 (see also Section 4398, page 1736, Compiled Laws of 1929), accepted the provisions of the Federal-Aid Act, approved July 11, 1916, of which the Federal-Aid Highway Act of 1944, approved December 20, 1944, is an amendment.

Related safety devices:

Highway authorities at their own expense furnish, renew and maintain, not less than 250 feet nor more than 350 feet from nearest rail advance warning signs as prescribed by the State Highway Commission. Sec. 3, Act 336, Eff. Sept. 18, 1931. See also Sec. 11404, 1940 Supplement to Compiled Laws of 1929.

Michigan—Continued.

Highway authorities may construct, install, operate and maintain at any railroad crossing automatic or mechanically operated barricading devices which, when giving warning, shall rise from a bed in the highway and become a barrier in such highway, subject to approval of Commission. Highway authorities to bear expense, unless railroad agrees otherwise in writing. Act 295, 1937, page 550, Eff. Oct. 29, 1937. See also Section 4631-1, et seq., page 454, 1940 Supplement to Compiled Laws of 1929.

Reflecting devices as a substitute for oil or electric lights:

Reflecting devices not permitted. See "Signals and interlocking" paragraph relating to lights on switch and derail lamps. Section 1, Act 189, 1921, p. 375, Eff. Aug. 18, 1921.

Minnesota.

Automatic train control:

No law or regulations.

Signals and interlocking:

219.93 (1866) provides that trains or engines must come to a full stop not less than 165 feet nor more than 990 feet from railroad crossings or junctions before proceeding unless an interlocking approved by the Commission is provided.

169.073 (1943) provides that red lights or signs shall not be maintained in the vicinity of a railroad if their indication is such as to interfere with efficiency or effectiveness of signals or devices used in operation of the railroad.

Other State statutes and rules and regulations of the Minnesota Railroad and Warehouse Commission applying to interlocking and automatic block signaling are no longer effective as the jurisdiction has been assumed by the Interstate Commerce Commission, effective August 26, 1937.

Highway grade crossing protection:

219.14 (1919) provides that the Minnesota Railroad and Warehouse Commission may on its own motion investigate any railroad-highway crossing and may, after hearing, order it protected "in any manner it may find reasonable and proper."

219.24 (1925) provides that the Commission may, after notice and hearing, in which it finds that conditions exist which require additional safeguards at railroad-highway crossings, specify the nature of the devices required and order the railroad company to install.

219.39 (1911) provides that upon complaint of village, city, town or county that a railroad-highway crossing is dangerous, the Commission shall investigate and hold a hearing.

219.40 (1911) provides that following such investigation and hearing as prescribed in 219.39, the Commission "may require the railroad company **** to adopt such safety device as the Commission may deem necessary for the proper protection of the crossing****."

219.26 (1925) provides that the Commission shall secure uniformity in the

Minnesota—Continued.

devices used to protect railroad-highway crossings. Such devices shall be approved by the Commission before installation.

Rules and specifications pertaining to signs and signals for use at railroad-highway grade crossings (Compilation of 1948).

Principal requirements:

(a) Electric highway crossing signals shall be of the flashing light type with rotating stop disc. Electric gates with flashing light signals of design approved by the Commission may be installed at multiple track crossings, in lieu of flashing light signals and rotating stop banner, when specifically authorized by the Commission.

(b) Installation of signals must meet the approval of the Commission.

(c) Detailed specifications are generally similar to Bulletin No. 3 of the Joint Committee on Grade Crossing Protection, A.A.R.

(d) All tracks over crossings shall be provided with track circuits.

(e) Signals shall display most restrictive indications as long as any part of the crossing is occupied.

(f) Bells may be used in conjunction with signals.

(g) Where conditions require, auxiliary control for signals shall be provided for slow speed and switching trains.

This State participates in Federal allotments for protection of highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

219.19 (1925) provides that railroad companies shall furnish advance warning signs for use at crossings specified by the Commission and the same shall be erected and maintained by the local authorities responsible for the street or highway in question.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Mississippi.

Automatic train control:

No law or regulations.

Signals and interlocking:

There is no specific regulation of installation, maintenance or inspection of railway signaling conferred by State statutes. The practice is generally in accordance with I.C.C. Rules.

Highway grade crossing protection:

Section 7857 provides that whenever the Public Service Commission shall declare the safety of the public to require, and shall so order, the railroad whose track crosses a thoroughfare must maintain a gate at the crossing thereof. The Commission may prescribe the material, dimensions and mode of operation of such gates.

Section 8039 gives the State Highway Commission exclusive jurisdiction

Mississippi—Continued.

and control of grade crossings and warning devices upon the State highway system.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Missouri.

Automatic train control:

No law or regulations.

Signals and interlocking:

Section 5627 provides the Public Service Commission with exclusive power to determine and prescribe the manner, including the particular point of crossing, and the terms of installation, operation, maintenance, apportionment of expenses, use and protection of each crossing of one railroad by another railroad or street railroad, and of a street railroad by a railroad, and of each crossing of a public road or highway by a railroad or street railroad and of a street by a railroad or vice versa, so far as applicable, and to alter or abolish any such crossing, and to require, where, in its judgment, it would be practicable, a separation of grades at any such crossing heretofore or hereafter established, and to prescribe the terms upon which such separation shall be made and the proportion in which the expense of the alteration or abolition of such crossings or the separation of such grades shall be divided between the railroad or street railroad corporations affected or between such corporations and the State, county, municipality or other public authority in interest: Provided, however, that in all cases of the State highways, not more than one-half of the cost of construction of any grade separation, overhead or underpass, authorized or ordered by the Commission shall be apportioned to the State Highway Commission.

Section 5695 provides the Commission with power to prescribe the installation, maintenance and operation of appropriate safety devices including interlocking, block signaling and other systems of signaling.

General Order No. 10 provides that no changes shall be made in the locking or in the location of any unit in an interlocking plant until plans have first been submitted to and approved by the Commission. It requires that plans for the construction of an interlocking plant shall be submitted to the Commission for approval and outlines the procedure to follow.

This order also provides that reports for each interlocking plant shall be filed with the Commission in the manner and form prescribed by it. These reports describing the general condition of the interlocking, as well as all failures, if any, in the preceding period, must be kept for each quarter and filed with the Commission.

Missouri—Continued.

Highway grade crossing protection:

See under "Signals and Interlocking."

Case No. 8308, Supplemental Order No. 3, requires the use of highway crossing signals in accordance with Bulletin 3 of the Joint Committee on Grade Crossing protection, A.A.R., pages 3 to 19 inclusive, issued October 1942, unless specifically excused by order of the Commission. Also plans for highway crossing protection must be submitted to the Commission for approval prior to installation.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Reflecting devices as a substitute for oil or electric lights:

Section 5282 (R. S. Mo. 1939). Lights to be placed on certain switches, when, by whom. "That all common carriers, their officers, agents and employees operating any railroad or part of railroad in this state, are hereby required on or before the first day of June (1915), nineteen hundred and fifteen, to adopt, put in use and maintain lights between sunset and sunrise, on main line switches, and all lead switches in yards, where cars are switched in making up or breaking up of trains: *Provided*, That this law shall not include branch lines where trains do not operate at night, or independent lines of less than fifty (50) miles in length: *Provided Further*, That the provisions of this section shall not apply to trailing point switches on double track. (R. S. 1929, sec. 4854.)"

Montana.

Automatic train control:

No law or regulations.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

The Board of Railroad Commissioners of Montana may order the installation of an electrically operated bell or other signaling device upon petition of any board of county commissioners when the contour of the country adjacent to the crossing is such that a person approaching it along a highway cannot, at a distance of 25 feet from the crossing, obtain an unobstructed view of the railroad track for a distance of one-half mile on either side of the crossing (R.C.M. 1935, Sec. 3842).

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Nebraska.

Automatic train control:

No law or regulations,

Nebraska—Continued.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

N.R.S. 1943, Section 75-219 (1921). The State Railway Commission has jurisdiction over all crossings of highways outside of incorporated villages, towns and cities, both public and private, across all railroads in the State of Nebraska, and has authority to make such rules and regulations for construction, repair and maintenance thereof as the Commission shall deem sufficient for protection of the public.

N.R.S. 1943, Section 75-221 (1921). Where any railroad track shall cross a highway in a cut, on a curve or side hill, in timber lands or near buildings or any obstruction of the view from the highway, the State Railway Commission shall direct such precautions to be taken as it deems necessary for the safety of the traveling public, the facts having been developed on motion of the Commission or on complaint of interested parties. The railroad company shall also provide and maintain such gates, crossings, signs, alarm bells and flagmen as the Commission shall direct. The Commission may adopt some uniform crossing sign which shall be placed at any crossing and at such other places as the Commission may direct. The Commission may direct the placement of special signs where physical conditions of any crossing warrant such action.

N.R.S. 1943, Section 75-430 (1925). Wherever a railroad crosses a public highway at grade outside of incorporated cities and villages, the railroad company and the county board of the county in which such crossing is located may agree upon changes, alterations or constructions of any such crossing as will promote public convenience or safety, and may also agree upon relocation of any highway to eliminate such crossings or carry them over or under such railroad, and upon the apportionment of expenses incident to any such changes or construction between the railroad company and the county or other public authority in interest. Upon failure to agree, an application may be filed with the State Railway Commission asking the Commission to make an order directing that the desired changes be made and designating what portion of the expense incident thereto shall be paid by the railroad company.

N.R.S. 1943, Section 39-729 (1927, Amended 1941). Power is conferred upon the Department of Roads and Irrigation to devise and supervise the manufacture and erection of stop signs, red flares or warning signs, and to erect and maintain such of them at railroad crossings where the same intersect highways where, in the judgment of the Department, it is deemed advisable. Also, for safety, concurrent power is conferred upon the board of county commissioners or supervisors to erect and maintain stop signs, red flares or warning signs of a standard approved by the Department of Roads and Irrigation where in the opinion of such body the public safety demands the same at the intersection of county highways and railroad crossings. The expense of the construction and maintenance of such stop signs, red flares or warning signs shall be borne exclusively by the railroad company when they are placed at railroad crossings.

Nebraska—Continued.

N.R.S. 1943, Section 15-261 (1901, amended 1929). A primary city may regulate railroad crossings, provide precautions, and prescribe rules for running engines or cars for prevention of accidents at crossings or on tracks. It may require railways to keep flagmen at all railway street crossings when necessary to public safety.

Reflecting devices as a substitute for oil or electric lights:

N.R.S. 1943, Section 74-581 (1913, amended 1947). The railroad shall equip with proper lights all switch stands to each and every switch leading from main tracks of any such road on which trains are generally operated at night, except lines fully equipped with automatic block signals. Lights or other signals may be ordered by the State Railway Commission to be installed on switch stands to other switches, including crossover switches and lead track switches in yards adjacent to main tracks where found reasonably necessary to safe operation, after hearing held upon complaint or upon motion of the Commission. Lights on such switch stands shall be in good condition constantly and shall be lighted and kept burning between the time of sundown and sunrise, and at such other times when, by reason of excessively foggy weather, the condition of such lights or signals would render it unsafe both for the employees of such railroad and for the general public; provided, that signals with reflex lenses may be substituted for lighted lamps under regulations prescribed by the Railway Commission and subject to the jurisdiction of such Commission to order the removal of the same, after complaint and hearing, if such signals with reflex lenses are found to be unsafe.

Nevada.

Automatic train control:

No law or regulations.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

Sec. 6118. Cooperation with State Highway Department. After hearing and investigation of a formal complaint or complaints by the state highway department, or the county commissioners of any county, or the town board or council of any town or municipality, or by any railroad company, the Commission shall have the power to determine and order for the safety of the travelling public, the elimination, alteration, addition or change of a highway crossing or crossings over any railroad at grade, or above or below grade, including its approaches and surface; changes in the method of crossing at grade, or above or below grade; the closing of a crossing and the substitution of another therefor; the removal of obstructions to the public view in approaching such crossing or crossings; and other such details of construction and operation as may be necessary to make grade, crossing elimination, changes and betterments for the protection of the public and the prevention of accidents effective; and in this behalf; the commission is hereby authorized and empowered to determine and order that the cost of such elimination,

Nevada—Continued.

removal, change, alterations or betterment as may be ordered shall be divided and paid in such proportion by the state, county, town or municipality and the railroad or railroads interested as shall be designated by the Commission.

This State participates in Federal allotments for protection at highway grade crossings.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

New Hampshire.

Automatic train control:

No law or regulations.

Highway grade crossing protection:

Chapter 299, Section 35 of the Revised Laws of New Hampshire authorizes the Public Service Commission to require a railroad to provide gates, automatic signals, flagmen, or to clear adjacent land of obstructions when in the opinion of the Commission public safety demands that the crossing be so improved. The cost incurred shall be divided between the railroad, town or state in such proportion as the Commission may determine to be equitable.

Order No. 3358 (Oct. 15, 1937) issued by the Public Service Commission requires railroads to install highway advance warning signs and the municipalities to thereafter maintain them.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

New Jersey.

Automatic train control:

No specific State law or regulations. The type of protection is at the discretion of the Board of Public Utilities Commissioners.

Signals and interlocking:

There are no specific regulations covering the installation or maintenance of signals and interlocking. The statutes provide that installations shall be "safe, adequate and proper," and delegate to the Board of Public Utilities Commissioners the authority to require the carriers to comply.

When changes and new installations are made, copies of the applications to the Interstate Commerce Commission are desired by the Board of Public Utilities Commissioners to insure compliance with the statutes. Practice in accord with the Interstate Commerce Commission Rules, Standards and Instructions is generally acceptable.

Highway grade crossing protection:

The type of protection is at the discretion of the Board of Public Utilities

New Jersey—Continued.

Commissioners. Installations of automatic highway crossing protection shall in general conform with the recommendations of the A.A.R., except in respect to automatic crossing gates the Board has established a minimum warning period of 30 seconds before the arrival of the fastest train at the crossing.

No carrier shall, without the approval of the Board of Public Utilities Commissioners, make any change in the form of protection.

In connection with the installation of short arm automatic crossing gates, a warning bell is generally required as a part of the installation, the bell to keep ringing until the gates have reached the horizontal position, and then stop.

The State of New Jersey participates in Federal allotments and the amount of reimbursement to the railroad is as agreed upon for each individual installation.

Related safety devices:

Railroads are required to furnish, install and maintain reflex advance warning signs at highway grade crossings even though not located on the railroad right-of-way. The use of "No Right Turn" and "No Left Turn" signs is very favorably regarded by the Board.

Reflecting devices as a substitute for oil or electric lights:

Reflecting devices such as reflectorized switch lamps, targets, signs, etc., are not covered specifically by legislation, but are subject to regulation by the Board of Public Utilities Commissioners.

New Mexico.

Automatic train control:

No law or regulations.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

Chapter 74 of the New Mexico Statutes 1941 Annotated gives the requirements for highway grade crossing protection.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

New York.

Automatic train control:

No law or regulations.

New York—Continued.

Signals and interlocking:

No specific regulations covering installations and maintenance. Under the provisions of the railroad law, 1947, Section 56, all trains and locomotives on railroads crossing each other at grade shall come to a full stop before crossing, and shall cross only when the way is clear and upon a signal from a watchman stationed at the crossing. The full stop may be discontinued if the Commission shall decide it to be impracticable or if, with the approval of the Commission, interlocking switch and signal apparatus is adopted and put in operation at such a crossing. The Commission may, whenever in its judgment public safety requires the erection of interlocking switch and signal apparatus, direct the erection of such devices.

The Public Service Commission has the power to determine if facilities are safe and adequate and to enter and inspect railroad facilities to determine if safe and adequate, with proper regulations, practices, equipment and appliances, and service in effect.

Approval of the Commission not required for interlocking changes.

Order of the Commission, dated May 28, 1946, Case No. 11660, requires that derailing devices should be installed at all sidings connected with main tracks, "except (a) at sidings connecting the main tracks within interlocking limits or where the movement from the siding to the main track is controlled by signal indication, (b) at sidings at locations where the attained maximum speed of scheduled passenger trains is not in excess of 30 miles per hour; and (c) at sidings having a grade of 0.35 per cent or more descending away from the main track upon which sidings operations are performed, except in emergency, only when the main track is occupied by a part of the train which does the switching service or where the main track switch protected by signal is kept reversed while the train is clear of the main track, and (c) on sidings which are not used, except in emergency, for clearing trains in territory where passenger trains are not permitted to enter a block until all other trains are clear of the main track." This Order further provides:

That the connection of derails with the signal system shall be in such a manner that when a derail is set for movement to or from a siding the signals protecting the main track movements in the vicinity will indicate that the derail is in non-derailing position, or in lieu of such connection with the signal system and in non-signalled territory derails shall be so connected with their main track switches that the derail may not be set for a movement from the siding until after or simultaneously with the operation of the switch for such movements.

The Order provides for appeal where the installation is claimed to be impracticable, unwarranted, undesirable or a hazard.

Highway grade crossing protection:

Installation of automatic grade crossing protection in general conforms with the recommendations of the A.A.R. The use of short arm crossing gates has been approved by the Commission.

Plans for installations and changes must be submitted to the Commission for approval.

In connection with highway grade crossing protection in Case No. 10723,

New York—Continued.

Order of the Commission, dated September 10, 1943, required the following additional protection:

1. Annunciators at all crossings with or without gates where watchmen are provided.
2. Electric lamps on all gates.
3. Where gates are in service and not continuously attended, install reflector signs "Gates Not Working."
4. Automatic flashing light signals at crossings protected by watchmen without gates.

Appeal for relief from above requirements may be made if physical, operating or other conditions make it impossible or impracticable to install or maintain the protection directed.

This State participates in Federal allotments for protection at highway grade crossings and reimburses railroads for such projects.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

North Carolina.

Automatic train control:

No law or regulations.

Signals and interlocking:

N.C. Code 1943, Sec. 62-49, empowers the North Carolina Utilities Commission to require a railroad to provide a block system or other safety device on any part of a railroad on which eight or more trains are operated each way daily.

N.C. Code 1943, Sec. 62-51, empowers the Commission to require the installation of interlockings at railroad crossings and drawbridges when the public safety demands such protection.

Highway grade crossing protection:

The State Highway Commission is authorized (Sec. 136-20) to require the construction of an overpass or underpass at dangerous crossings or to require the installation of gates or other safety devices at grade crossings, one-half of the cost of installation to be borne by the Commission and one-half by the railroad. The Commission will bear no part of the maintenance costs except in the maintenance of an overpass.

North Carolina participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects, with the exception that the State and railroads each bear 50 per cent of the cost of surveys, plans, specifications and estimates.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

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Com. III—Auto. Train Control and Signals

North Dakota.

Automatic train control:

No law or regulations.

Signals and interlocking:

By statute, it is the duty of the railroads to provide such service and equipment as shall promote the safety and convenience of its employees and the public. (N.D.R.C., 1943, Sec. 49-0401.)

The Public Service Commission of North Dakota may, after hearing, prescribe by its order, rule or regulation for proper service or equipment (Sec. 49-0204). Subject not specifically included.

Highway grade crossing protection:

The Commission may, upon written complaint by State Highway Commission, any board of county commissioners, any board or supervisors of a township, any officer, board, or agency having jurisdiction over public highways, or upon its own motion, order any railroad grade crossing protected in any manner it may find reasonable and proper. (N.D.R.C. 1943, Secs. 24-0908 and 49-1113.) No devices used to protect grade crossings shall be installed until the same have been approved by the Commission (Sec. 24-0909).

North Dakota participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Ohio.

Automatic train control:

No law or regulations.

Signals and interlocking:

Sec. 8826 (1882) requires that where the tracks of two railroads cross each other or in any way connect at common grade, a watchman shall be maintained at joint expense of railroads. All trains or engines must come to a full stop not nearer than 200 feet, nor farther than 800 feet from crossing and not cross until signalled to do so by watchman, nor until way is clear.

Sec. 592 (1896) provides that if an interlocking is installed at grade crossings or drawbridges and, if approved by the Commission, train or engines may operate over crossing or drawbridge without stopping.

Sec. 594 (1908) provides that Commission may order railroads, crossing at grade, to install interlocking to protect the crossing, if in its opinion public safety requires such protection.

July 1, 1914—The Commission issued rules governing the installation and operation of interlockings at railroad crossings and drawbridges.

Sec. 614-3 (1929). The Public Utilities Commission of Ohio is vested with the power and jurisdiction to supervise and regulate railroads in respect to

Ohio—Continued.

the protection, welfare and safety of railroad employees and the traveling public.

Highway grade crossing protection:

Sec. 588 (1890) provides that the Commission, if public safety requires, may require that grade crossings of highway and railroads be protected by gates, watchmen, or automatic protection at the expense of the railroad provided that the Commission have declared the crossing as dangerous.

Sec. 590 (1894) prescribes the manner of providing highway protection required by the Commission.

Sec. 591 (Amended) prohibits the abandonment of highway gates or watchman or substitution of automatic protection thereof. (Relief from this section may be obtained by the Commission.)

If a crossing within a municipality is considered dangerous and a traffic hazard has been established, authorities of the municipality having jurisdiction may construct, purchase and operate a safety device and the cost thereof shall be borne by the municipality.

Sec. 591-1 (1927) provides that the municipality shall place a warning sign not less than 200 feet from a safety device installed in a street for protection of traveling public.

This State participates in Federal allotments for protection at highway grade crossings.

Railroads pay 10 per cent of cost within estimate, but all in excess of estimate.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Oklahoma.

Automatic train control:

No law or regulations.

Signals and interlocking:

Sec. 27, Article IX, provides that in case any railroad company shall seek to cross at grade the track or tracks of another railroad, the railroad seeking to cross at grade, within a reasonable time, shall be compelled to interlock or protect such crossings by safety devices to be designated by the Corporation Commission of Oklahoma and all costs of appliances, together with expense of putting them in, shall be borne equally by each company, provided that this act shall not apply to crossings of side tracks.

Highway grade crossing protection:

Title 17, Sec. 82, gives the Corporation Commission exclusive jurisdiction to determine and prescribe the location and type of protection required.

Title 17, Sec. 82 (1941), provides that the expense of construction and

Oklahoma—Continued.

maintenance of public highway grade crossings shall be borne by the railroad involved; also provides in case of overgrade and undergrade crossings, assignment of cost and maintenance shall be left to the discretion of the Corporation Commission; but in no event shall the city, town or municipality be assessed more than 50 per cent of the actual cost.

Title 66, Section 125 (a), provides for public authorities having jurisdiction of public highways or streets to require railroads to install and thereafter maintain and operate an automatic or mechanically operated barricade device. The detailed plans of such devices with the description of proposed mode of operation and map showing the proposed location, must be first submitted to and approved by the State Highway Commission.

Title 66, Section 125 (b), provides for reflector warning signs to be installed where the barricades provided for in Section 125 (a) are installed; said warning signs to be installed not less than 400 feet from the crossing where highway speed in excess of 30 miles per hour is permitted, and not less than 200 feet from the crossing when highway speed not in excess of 30 miles per hour is permitted.

There are no statutes prescribing the type of highway crossing protection devices to be used but the Corporation Commission customarily desires the flashing light type signals as recommended by A.A.R.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

*Oregon.**Automatic train control:*

No law or regulations.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

Order No. 4057 (Feb. 13, 1937), issued by the Public Utilities Commission, establishes certain requisites for crossing protection in substantial conformity with recommendations of the Joint Committee on Grade Crossing Protection, A.A.R.

House Bill No. 250, passed by the State Legislature and signed by the Governor March 4, 1947, takes away from all cities and towns, except the City of Portland, the power to prescribe maximum speed limits of trains within the municipal boundaries and invests such power in the State. It provides that upon petition of any railroad or of any city or town, the Public Utilities Commissioner, after hearing, shall determine maximum speed limits. It also gives the Public Utilities Commissioner the power to prescribe

Oregon—Continued.

in the same order in which the speed limits are fixed, the type of crossing protection, if any, which shall be installed, and to divide the cost of such installation and maintenance between the city and railroad in accordance with the benefits derived respectively by each.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Pennsylvania.

Automatic train control:

No law or regulations.

Signals and interlocking:

Railroad regulations, issued by the Pennsylvania Public Utility Commission in 1946, govern carriers subject to the jurisdiction of the Commission. Installations made in compliance with the Interstate Commerce Commission Rules, Standards and Instructions are acceptable. The State does not generally prescribe the details of signal installations and interlockings. No carrier shall, without Commission approval, remove the protection afforded by interlocking signals or alter any existing form of protection at crossings, at grade, of the tracks of a carrier across the tracks of another carrier.

Highway grade crossing protection:

Railroad Regulations, issued by the Pennsylvania Public Utility Commission in 1946, govern carriers subject to the jurisdiction of the Commission.

Automatic highway grade crossing signals, in general, shall conform to Bulletin No. 3 of the Joint Committee on Grade Crossing Protection, A.A.R. The Commission, in cooperation with the railroad, analyzes each individual installation and specifies such modifications as may be found necessary. Prior to installing automatic crossing signals at any unprotected crossing of a public highway, at grade, across its track or tracks, or at such a crossing which is protected by fixed signs only, a carrier shall submit to the Commission plans of such proposed installation and receive approval of such plans.

No carrier shall without Commission approval, remove the protection afforded by crossing gates, watchmen, automatic crossing signals or any other protection against accidents or reduce the number of hours that manual protection is maintained or substitute or alter any existing form of protection at crossings at grade, of the tracks of a carrier across a public highway.

The Department of Highways may, upon proper application to and ap-

Pennsylvania—Continued.

proval of the Pennsylvania Public Utilities Commission, participate to the extent of one-half of the actual cost (or such other proportion as agreed to) of installing protection at State highway grade crossings. Similarly, the Commission itself may participate in the cost of installation of such protection at street and highway crossings.

The carriers affected shall install and maintain the signals.

In Pennsylvania the Department of Highways handles Federal Aid highway grade crossing funds subject to approval of the Federal authorities. If recommended by that Department, Federal Aid Highway Funds may be used in paying for a portion or all of the costs of flashing light signal protection at public grade crossings.

Related safety devices:

If advance warning signs or other similar facilities are installed along the highway leading to the crossing, the cost of such facilities, and work and expense of their installation and maintenance shall be borne and performed in such manner as agreed upon by the parties or as directed by the Commission.

Reflecting devices as a substitute for oil or electric lights:

No law or rules are in effect, but such devices are subject to regulation by the Commission.

Rhode Island.

Automatic train control:

No law or regulations.

Signals and interlocking:

Title XVI, Chapter 122 (1938) Par. 47. The Division of Public Utilities may, after hearing and investigation, order reasonable repairs, improvements, changes, additions, alterations or extensions to the plant or equipment of any Public utility and may set a reasonable time limit on same, subject to the right of appeal.

Chapter 124, Par. 8 (1938). Trains shall be brought to a full stop within 500 feet of any drawbridge, railroad crossing at grade or junction and shall then proceed past same at not more than 6 miles per hour unless, in the opinion of the Division, it is consistent with public safety to grant the privilege of passing without stopping.

Chapter 124, Par. 11 (1938). The Division may prescribe rules and regulations for operation at railroad crossings at grade.

Highway grade crossing protection:

Chapter 124, Par. 6 (1938). At every public grade crossing the railroad shall erect on each side of the crossing a suitable signboard painted in black capital letters reading "RAILROAD CROSSING. STOP, LOOK AND LISTEN" and shall also adopt such other precautionary measures as shall be deemed proper by the Division.

Rhode Island—Continued.

Chapter 124, Par. 41 (1938). Within the City of Providence, every railroad shall erect, maintain and operate gates at all crossings, satisfactory in all respects to the Board of Aldermen of that City.

Chapter 124, Par. 43 (1938). All railroads shall cause flagmen or gates or other precautionary measures or appliances to be established or substituted at public crossings whenever, in the opinion of the Division, it is necessary for the public safety.

Chapter 124, Par. 47 (1938). At crossings where gate or flagman is not maintained the Division may, after notice and hearing, direct in writing that such crossings shall be furnished with such electric light signal or signals as they shall decide is required.

This State participates in Federal allotments for protection at highway grade crossings.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

South Carolina.

Automatic train control:

No law or regulations.

Signals and interlocking:

S.C. Code 1942, Sec. 8225, gives the South Carolina Public Service Commission power to require the installation of such safety devices as are, in their opinion, necessary or desirable.

Highway grade crossing protection:

See under Signals and interlocking.

South Carolina participates in Federal allotments and reimburses the railroads for such projects, with the exception that the State does not bear any part of the cost of surveys, plans, specifications and estimates.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

South Dakota.

Automatic train control:

No law or regulations.

Signals and interlocking:

52.0940 (1909) provides that the Public Utilities Commission may require railroads to "install such signal system—or any other device or appliance

South Dakota—Continued.

that in its judgment will best promote the public safety." The Commission may require railroads to install interlocking at railroad crossings, junctions and drawbridges, and determine division of cost between respective companies if necessary.

It is the usual practice to submit general plans covering major changes and additions to interlocking facilities to the Commission for approval. Other plans are not submitted.

On February 14, 1914, the Commission adopted certain rules pertaining to interlocking which are identical to those adopted by Wisconsin.

Highway grade crossing protection:

28.1101 (1919) provides that upon complaint or upon its own motion, the Commission may, after proper investigation of any railroad-highway grade crossing, prescribe the method of protection required in the interest of public safety.

28.0901 (1919) requires that railroad companies will furnish and install approach warning signs at all highway crossings except within the limits of incorporated villages and cities. Signs to be located not less than 150 feet nor more than 180 feet from the point of crossing.

There are no specific rules relating to highway crossing protection. It is not the practice to submit plans to the Commission for approval.

This State participates in Federal allotments for protection at highway grade crossings.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

52.0936 (1909) requires lighted switch lamps on all main track switches where trains operate at night. In 1943 the statute was amended to permit the use of reflectorized switch lamps "where, on the average, not more than one switching movement occurs between sunset and sunrise."

*Tennessee.**Automatic train control:*

No law or regulations.

Signals and interlocking:

Sections 2634, 2635 and 2637 of Williams Tennessee Code provide that trains must be stopped at railroad crossings unless the crossing is interlocked and, except when the intersecting roads are under the management of the same company, engine and trains run upon the longer road are not required to stop.

Highway grade crossing protection:

As a result of certain court decisions, municipalities appear to have the power to require railroads to provide crossing protection.

Tennessee participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Tennessee—Continued.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Texas.

Automatic train control:

No law or regulations.

Signals and interlocking:

Articles 6371 (1942 Supplement) and 6502, Texas Statutes, provide that trains must be stopped at railroad grade crossings unless interlockings are provided, and the Railroad Commission is authorized to require and specify such interlockings. In 1927 the Railroad Commission of Texas issued circular No. 7454-A setting forth specifications for interlockings, requiring submission and approval of plans, and requiring inspection and reports.

Highway grade crossing protection:

No law or regulations.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

The State Highway Department place and maintain the reflectorized signs in approach to railway crossings at grade.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Utah.

Automatic train control:

The State Public Service Commission has jurisdiction of automatic train control, signals, interlocking and highway grade crossing protection but up to the present time has exercised its regulatory powers only over grade crossing matters, both railroad and public highway.

Signals and interlocking:

See under Automatic train control.

Highway grade crossing protection:

See under Automatic train control.

Related safety devices:

Local authorities install and maintain reflectorized signs in approach to railway crossings at grade except in Federal Aid projects. Railroads are required to furnish and install such signs but the expense of same is reimbursable from participating funds, the contract for each individual project

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Com. III—Auto. Train Control and Signals

Utah—Continued.

specifically mentioning this feature. Also the contract provides that maintenance and repair of such signs is to be the responsibility of either the State, county or city.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Vermont.

Automatic train control:

No law or regulations.

Signals and interlocking:

The Public Service Commission may (Sec. 6234, Chap. 254, Public Laws of Vermont) require a railroad to provide protection at certain grade crossings and may specify when and how such protection is to be provided.

Highway grade crossing protection:

No law or regulations.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Virginia.

Automatic train control:

No law or regulations.

Signals and interlocking:

Chapter 155, Sec. 3989 gives the State Corporation Commission authority to require any company operating a railroad to establish and maintain the block system or some other equally efficient system to regulate the movement of its trains, in order to prevent collisions.

Chapter 155, Sec. 3987—When Trains Shall be Stopped Before Getting to Railroad Crossing—"Whenever railroads cross each other on the same grade in this State, the trains shall be brought to a full stop at least 50 feet before getting to the crossing; but the provisions of this section shall not be applicable where the crossings of such roads are regulated by derailing switches, or other safety appliances, which prevent collision at crossing, nor where a flagman or watchman is stationed, or signal tower is located, and signals that the trains may cross in safety."

Highway grade crossing protection:

No law or regulations.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

Virginia—Continued.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Washington.

Automatic train control:

By statute, the Department of Transportation of Washington may, after hearing, make an order directing reasonable repairs, additions, or improvements in equipment or facilities to promote security or convenience of the public or employees (RRS Sec. 10400). Subject not specifically included.

Signals and interlocking:

See under Automatic train control.

Highway grade crossing protection:

By statute, the Department may order a railroad to install and maintain at grade crossings, proper signals, warnings, flagmen, interlocking devices or other devices or means to secure the safety of the public and its employees (RRS Sup. Sec. 10513).

The authority of the Department does not extend to the crossings in cities which are authorized to frame their own charter (over 20,000 population) (RRS Sec. 10531). Authority there is vested in the city governmental body.

Washington participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

This State has adopted the new Manual "Uniform Traffic Control Devices for Streets and Highways" of the American Association of Traffic Engineers and National Conference on Streets and Highway Safety.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

West Virginia.

Automatic train control:

No law or regulations.

Signals and interlocking:

West Virginia Code 1943 Sec. 31 Art. 2-8-3104 requires trains to stop at unprotected railroad crossings, provided the railroad crossings are not equipped with fixtures approved by the Public Service Commission.

Highway grade crossing protection:

No law or regulations.

This State participates in Federal allotments for protection at highway grade crossings and reimburses the railroads for such projects.

West Virginia—Continued.

Related safety devices:

No law or regulations.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Wisconsin.

Automatic train control:

No specific State laws or regulations. See Sections 195.26 and 195.03 below.

Signals and interlocking:

192.28 (1872) provides that trains or engines must come to a full stop within 400 feet of railroad crossings and within 600 feet of drawbridges before proceeding unless signaled to proceed by a man on the ground or unless an interlocking approved by the Public Service Commission is provided. Does not apply to steam roads at crossings with electric railroads.

195.26 (1911) provides that railroads shall provide reasonable safety devices. Public Service Commission may order railroads to provide block system or other safety devices.

It is the practice to submit detailed plans covering all changes and additions to automatic block signal systems and interlocking facilities to the Commission for approval.

195.03 (p. 18) (1907) provides that Commission shall establish rules and regulations for installation, operation and maintenance of all safety devices and measures.

Rules pertaining to interlocking were adopted by the Commission October 8, 1913. Principal requirements are as follows:

- (a) Plans covering new installations and changes in existing facilities must be submitted to the Commission for approval.
- (b) Following completion of new work or major changes, interlockings must be placed in conditional service for not less than 24 hours and until approved by Commission Inspector.
- (c) Requisites for interlocking systems are generally less restrictive than those of the Interstate Commerce Commission. Derails are required at crossings, junctions and drawbridges but this requirement has been generally waived by the Commission in recent years.
- (d) Quarterly inspection reports for each interlocking must be filed with the Commission by the maintaining railroad company.

See "Rules Governing the Construction, Maintenance and Operation of Interlocking Plants" adopted by the Railroad Commission of Wisconsin, effective December 1, 1913.

Highway grade crossing protection:

192.29 (1872) provides that trains or engines will not exceed 15 miles per hour within 330 feet of any public crossing in a city or village. If gates or flagmen are provided, speed of trains or engines will not exceed 30 miles per hour within 330 feet of crossing and if electric bell or signal is provided,

Wisconsin—Continued.

speed of train or engine will not exceed 20 miles per hour within 330 feet of crossing. Flagmen, gates, or mechanical devices shall be placed at crossing as directed by village or city authorities.

195.28 (1905) provides that upon complaint of village, city or town that a railroad-highway crossing is dangerous, the Commission may, after proper investigation and procedure, order the railroad company to provide gates, flagmen, electric signal, or other safety devices if required.

By order (R 3674) of the Commission dated August 12, 1929, the use of either wig-wag signals or flashing light signals with rotating stop discs is specified for highway crossing protection. Plans must be submitted to the Commission for approval.

In recent years the Commission has approved the use of automatic gates.

Related safety devices:

192.48 (1917) requires railroad companies to furnish advance warning signs for use at railroad-highway crossings outside the limits of incorporated villages or cities except at crossings with state trunk highway system. Signs are furnished to County Highway Commissioners who are in turn responsible for installation and maintenance. Signs for crossings with state trunk highway system are furnished, installed and maintained by the State Highway Department except within limits of villages and cities.

This State participates in Federal allotments for protection at highway grade crossings.

Reflecting devices as a substitute for oil or electric lights:

Commission Order (R-3122), dated July 15, 1924, and effective August 24, 1924, requires that all main track switches be equipped with switch lamps, except on trailing point switches in automatic block signal territory and at locations where "the number of trains operating during any period between sunset and sunrise shall not be more than two per week."

Commission Order R-3122 was amended October 17, 1942, to permit use of reflectorized switch lamps after making application to the Commission and receiving informal approval.

Commission Order R-3122 was further amended February 28, 1947, to provide for the Commission issuing public notice of application to install reflectorized switch lamps. If requested within 20 days of such public notice, a hearing will be held, otherwise the application will be disposed of by informal approval.

*Wyoming.**Automatic train control:*

No law or regulations.

Signals and interlocking:

No law or regulations.

Highway grade crossing protection:

No law or regulations.

Wyoming—Continued.

This State participates in Federal allotments for protection at highway grade crossings.

Reflecting devices as a substitute for oil or electric lights:

No law or regulations.

Canada.

All railways, rail level crossings, junctions and movable bridges, as well as protection at highway crossings, are governed by a Federal law known as the "Railway Act" (Statutes of Canada 1919, Chapter 68, and subsequent amendments), and the Provinces have no jurisdiction in such matters. The Act is administered by the Board of Transport Commissioners for Canada, hereinafter referred to as the "Board."

Level crossings and movable bridges:

Section 252 of the Railway Act provides that the tracks of any railway Company shall not cross or join with the tracks of any other company until permission has been obtained from the Board, and that no train shall be operated until the Board authorizes such operation by an Order.

Section 254 provides that the Board may order installation at any such crossing or junction, of an interlocking system as the Board may deem renders it safe for engine and trains to pass over such crossing or junction without being brought to a stop.

Section 305 provides that trains shall be brought to a full stop before crossing any draw or swing bridge, and shall not proceed until a proper signal has been given, and further provides that where there is an interlocking or other devices in service, the Board may, by Order, permit trains to pass over such bridges without stopping, with such regulations as to speed and other matters as the Board may decide.

Sections 306 and 307 provide that trains, engines or electric cars shall not pass over any crossing at rail level of two main lines or branch lines until a proper signal has been received by the train from a watchman in charge of such crossing, and in the case of an electric car, provides that where no watchman is in charge of the crossing, conductor is to proceed to the crossing, and, if way is clear, give proceed signal to motorman.

Section 307 provides that all engines, train or electric cars shall stop before passing over any crossing at rail level, and further provides that where an interlocking or other device is in service, the Board may, by Order, permit trains to pass over such crossings without stopping, with such regulations as to speed and other matters as the Board may decide.

Highway crossings:

Section 256 grants the Board wide powers in respect to highway crossings, and among others provides that it must approve all new crossings and may order watchmen or protection; it may order protection at existing crossings or order the highway carried over or under the railway.

Section 262 provides for a Fund to aid in the protection or elimination of highway crossings. This Fund is known as the "Railway Grade Crossing

Canada—Continued.

Fund" and the Board is limited to appropriating a sum of not more than 40 per cent of the cost of any one crossing, and in no case exceeding \$100,000.00.

Section 309 as amended by Parliament and covered by General Order No. 704 requires that the speed of trains shall not exceed a speed of 25 miles per hour over any highway crossing at which a person or vehicle has been struck by a train, and bodily injury or death results, until such crossing is protected to the satisfaction of the Board.

Section 283 authorizes the Board to inspect any railway or any portion thereof if considered dangerous to the public using same, from want of renewal or repair or insufficient or erroneous construction, or from any other cause and may order any repairs, renewals, reconstruction, alterations or new work to be made.

General Order No. 547 (amended by General Order 572) covers regulations regarding plans to be filed with the Board under Sections 252 and 305 of the Railway Act, also covers general requirements for interlocking appliances.

General Order No. 607 covers specifications for highway crossing signals of the flashing light type.

General Order No. 675 covers specifications for highway crossing signals of the wig-wag type.

General Order No. 676 (amended by General Order No. 680) covers specifications for automatic gates.

Communications for the Board should be addressed: The Secretary, Board of Transport Commissioners for Canada, Ottawa, Ontario, Canada.

Action Recommended

Acceptance as information.

AUTOMATIC TRAIN CONTROL AND AUTOMATIC CAB SIGNALS
IN THE UNITED STATES AS OF JANUARY 1, 1949

TABLE I

Automatic Train Control Installed as of January 1, 1949

Railroad	Type	Territory	Miles		Equipped locomotives and motor cars
			Road	Track	
A. T. & S. F.	Union 3-Speed	Pequot, Ill.—Ft. Madison, Iowa	175.4	355.0	183
A. C. L. (1)	General Int.	Richmond, Va.—Florence, S. C.	298.9	589.2	213
B. & O.	General Int.	Point of Rocks, Md.—Philadelphia, Pa.	166.4	332.8	277
B. & A.	General Int.	Boston, Mass.—Rensselaer, N. Y., and Brookline Jct.—Riverside, Mass.	208.3	499.9	168
B. & M. (2)	General Int.	Soapstone—North Adams, Mass.	8.6	19.5	—
C. & O.	Union Int.	Orange—Clifton Forge, Va.	123.2	123.2	85
(P. M. Dist.)	General Int.	Grand Rapids—Detroit, Mich.	135.0	146.0	147 (3)
C. & E. I. (4)	Miller Ramp	Dolton, Ill.—Jackson, Ind.	141.5	283.0	126
C. & N. W.	General 2-Speed	Chicago, Ill.—Co. Bluffs, Iowa	506.3	1,031.6	278
C. C. C. & St. L.	General Int.	Indianapolis, Ind.—Lenox, Ill.	235.2	384.5	289
Erie	General Int.	Port Jervis—Hornell, N. Y.	242.2	484.2	158
G. M. & O.	National Int.	Chicago—Bloomington, Ill.	113.8	203.5	56
H. & M. (5)	Auto. Trip	N. Y.—Hoboken and Jersey City, N. J.	8.5	18.0	302
I. C.	Union Con. Stop	Champaign—Branch Jct., Ill., and Waterloo—Ft. Dodge, Iowa	219.6	343.5	193
L. V.	General Int.	Newark, N. J.—Sayre, Pa.	283.2	636.4	219
L. I.	Auto. Trip	Brook Tower—Brooklyn and East New York—Dunton and 4 Drawbridges	7.7	15.2	785
L. & N. (6)	Union 1-Speed	Corbin, Ky.—Etowah, Tenn.	161.7	161.7	52
	Union Con. Stop	Mobile, Ala.—New Orleans, La.	136.2	147.5	58
M. C. (7)	General Int.	Detroit, Mich.—Kensington, Ill.			
		Detroit, Mich.—Alexis, Ohio	315.5	631.0	260
N. Y. C. (8)	General Int.	Croton, N. Y.—Englewood, Ill., and Rochester—Suspension Bridge, N. Y.	1,031.5	3,325.6	1,067
N. Y. C. & St. L.	Union Int.	Ft. Wayne, Ind.—Chicago, Ill.	139.1	157.6	96
Pac. Elec.	Union Solenoid	Thru Subway, Los Angeles, Calif.	1.0	2.0	197
Penna. (9)	Auto. Trip	East and North River Tunnels	7.4	20.2	2

Sept. 1949]

Com. III—Auto. Train Control and Signals

Signal Section, A.A.R.

TABLE 1—Continued

Railroad	Type	Territory	Miles		Equipped locomotives and motor cars
			Road	Track	
P. & L. E.	Union Int.	Pittsburgh, Pa.—Youngstown, Ohio	63.7	206.1	80
R. F. & P. (10)	Union 2-Speed	Richmond—Pot. Riv. Bridge, Va.	109.7	232.0	73
Sou. Sys.	General Int.	Spencer, N. C.—Howell, Ga.			
		Salisbury, N. C.—Morristown, Tenn.			
		Hayne, S. C.—Biltmore, N. C.			
		Lot, Ky.—Holton, Tenn. (6)			
		Bristol, Va.—Ooltewah, Tenn.			
		Charlotte, N. C.—Columbia, S. C.			
		Stevenson, Ala.—Memphis, Tenn.			
		Citico, Tenn.—Jacksonville, Fla.			
		Austell, Ga.—Birmingham, Ala.			
		Haleyville—Jasper, Ala. and			
		Ludlow, Ky.—New Orleans, La.	2,716.8	3,489.0	788
S. P.	National Int.	Oakland—Pittsburg, Calif., and	99.6	188.2	280
		Gold Run—Truckee, Calif.	84.0	86.5	66
U. P. (11)	Union 1-Speed	Portland—The Dallas, Ore.			
Total*			7,740.0	14,112.9	6,498

Notes:

- (1) Includes 2.8 miles of road and 5.7 miles of track on the R. F. & P.
- (2) Locomotives included in Table II.
- (3) Includes 31 locomotives in Canada.
- (4) Fifty-four of the locomotives listed have composite equipment for operation over the C. C. C. & St. L.
- (5) Sixty-six of the locomotives listed are also equipped with automatic cab signals.
- (6) Includes 4.6 miles of road and track shown on both L. & N. and Sou.
- (7) Does not include 240.7 miles of road and 481.3 miles of track equipped in Canada; includes 58 locomotives and 3 motor cars operating over that track.
- (8) Includes 7.7 miles of road and 15.21 miles of track between Alexis and Swan Creek.
- (9) Includes 6.39 miles of road and 18.58 miles of track also equipped for cab signal operation.
- (10) One locomotive, in special service, not equipped with speed governor.
- (11) Does not include 30 locomotives equipped for operation over both cab signal and train control territory, which are included in Table II.

* Does not include G. R. S. Continuous coded 4-speed on Key System involving 9.75 road miles, 19.5 track miles, and 93 equipped locomotives and motor cars.

TABLE II
Automatic Cab Signals Installed as of January 1, 1949

Railroad	Union Cont.	Inds.	Territory	Road	Miles Track	Equipped locomotives and motor cars
B. & M. (1)	Non-code	2	W. Cambridge—E. Deerfield, Mass.	99.1	203.8	186
C. of N. J. (2)	Non-code	3	Red Bank—Lakehurst, N. J.			
	Code	4	Elizabeth—N. E. Raritan River, and			
	Code	4	Matawan—Atlantic Highlands, N. J.	49.5	64.0	66
C. M. St. P. & P.	Non-code	3	Portage, Wis.—Hastings, Minn.	208.6	414.5	142
C. R. I. & P.	Code	4	Blue Island—Rock Island, Ill.	166.0	332.0	135
D. L. & W.	Non-code	2	E. Buffalo, N. Y.—Scranton, Pa.	256.6	523.2	167
L. I. (3)	Code	3	Jamaica—Babylon, L. I.			
	Code	3	Harold Intkg.—Pt. Washington, L. I.			
	Code	3	Ewd. and Wwd. thru Harold Intkg. on			
			N. Y. con'g. R. R. tracks and North Side			
			Br. tracks	44.1	85.1	382
N. Y. & L. B. (4)	Code	4	N. E. Raritan River—Bay Head Jct., N. J.	39.6	78.0	—
N. Y. N. H. & H. (5)	Non-code	2	New Haven, Conn.—Springfield, Mass.			
	Code	4	New Haven, Conn.—Cranston, R. I.	162.8	358.7	253
N. & W.	Non-code	3	Roanoke, Va.—Hagerstown, Md.	238.7	251.6	88
Penna. Sys. (6)	Code	4	"Harold" L. I., New York—Washington			
			Baltimore, Md.—Harrisburg, Pa.			
			Indianapolis, Ind.			
			Philadelphia—Pittsburgh, Pa.—			
			Conpitt—Kiskiminetas Jct., Pa.			
			"Shore," Pa.—"Vernon," N. J.			
			Jersey City—Hudson, N. J., and			
			Rahway—Woodbridge Jct., N. J.	1,308.8	3,609.9	2,760
P.-R. S. L.	Code	4	Camden—Atlantic City, N. J., and			
	Code	4	So. Camden—Winslow, N. J.	82.4	162.6	14
Reading	Code	4	Jenkintown—Bethlehem, Pa.	45.7	91.3	157
U. P. (7)	Non-code	2	N. Platte, Nebr.—Cheyenne, Wyo.	225.0	450.0	183
	Code	2	Laramie—Hanna, Wyo.	77.0	154.0	44
				Total	3,003.9	6,778.7
						4,228

(See notes on following page)

TABLE II—Continued

Notes:

- (1) Includes 67 locomotives equipped with intermittent inductive automatic train stop in addition to cab signal equipment. These are included in total as they are not included in Table I.
- (2) Twenty-one of these locomotives have composite equipment for operation over both non-code and code cab signal territory.
- (3) Includes 331 MU cars and 18 locomotives equipped with both automatic trip stop and cab signals. These (349) are not included in total, as they are included in Table I.
- (4) Locomotives same as C. of N. J. P. R. R. operates 20 equipped locomotives and 24 equipped motor cars over this territory.
- (5) One hundred and twenty-eight of these locomotives have composite equipment, 23 U. S. & S. and 105 G. R. S. for operation over both non-code and code cab signal territory.
- (6) Includes 33.0 miles of road and 88.7 miles of track on the B. & O. (Newark—Columbus, Ohio), equipped for operation of cab signal locomotives of Pennsylvania.
- (7) Includes 30 locomotives equipped to operate over both cab signal and speed control territory.

Summary of Automatic Train Control and Automatic Cab Signals
in the United States as of January 1, 1949

	Road miles	Track miles
Automatic train control.....	7,740.0	14,112.9
Automatic cab signals.....	3,003.9	6,778.7
Total—automatic train control and cab signals.....	10,743.9	20,891.6
Locomotives equipped (includes motor cars and multiple-unit cars):		
Continuous control, speed control, and cab signals.....		652
Continuous control and cab signals.....		251
Intermittent control without speed control.....		5,246
Cab signals.....		4,577
Exclusively for operation over foreign lines.....		187
Total locomotives equipped.....		10,913

Action Recommended

Acceptance as information.

HEARINGS SET BY THE INTERSTATE COMMERCE COMMISSION UNDER
THE SIGNAL INSPECTION ACT (DOCKET 28000) FOR THE YEAR 1948*

Docket 28000 Sub. No.	RS&I or BS-Ap No.	Railroad	Location	Proposed Changes	Date held	Date granted	Date denied
104	RS&I No. 295	Penna. and Long Island	Various	Modification of Sec. 677 of RS&I as applied to certain PRR and LIRR multiple- unit cars	1-16-48	3-24-48	
105	BS-Ap No. 9782	Rutland and Cen. Vt.	Burlington, Vt.	Modification of interlocking	9-13-48	12-1-48	(See Note 1)

Note 1: Approval effective when a Diesel locomotive is put in regular service by the Central Vermont between Burlington and Essex Junction, Vt.

* Previous report on this subject appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, p. 101.

Summary of Hearings

Year	No. Hearings			Granted	Disposition	
	Set	Held	Cancelled		Denied	Dismissed
1938	3	3	—	1	2	—
1939	23	17	6	17	(See Note 1)	—
1940	18	18	—	10	7	1
1941	27	23	4	22	1	—
1942	21	19	2	17	2	—
1943	5	5	—	5	—	—
1944	—	—	—	—	—	—
1945	2	2	—	2	(See Note 2)	—
1946	2	1	1	—	(See Note 3)	1
1947	3	3	—	1	1	1 (Note 3)
1948	2	2	—	2	(See Note 4)	—
Totals	106	93	13	77	13	3

Notes:

- 1—One of these denied in part.
- 2—An amended application in one of these was approved.
- 3—Application withdrawn at hearing.
- 4—Approval of one of these effective when Diesel locomotive is placed in regular service.

Action Recommended

Acceptance as information.

COMMITTEE IV—AUTOMATIC BLOCK SIGNALING

Personnel

E. N. Fox, Chairman

L. B. Yarbrough, Vice-Chairman

H. D. Abernethy	T. H. Kearton
C. M. Acker	W. T. Lewis
R. B. Amsden	P. H. Linderth
J. A. Beoddy	H. A. Maynard
L. S. Bottinelli	C. F. Nelson
F. L. Chatten	S. E. Noble
W. L. Dayton	M. A. Otterbourg
C. E. Hartvig	D. H. Steiner
J. R. Heisler	H. G. Stiebeling
I. S. Jones	R. E. Taylor
A. L. Jordan	W. G. Trost

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on protection against lightning.
4. Specification or requisites for drills used in bonding.
5. Specifications for various units comprising centralized traffic control, collaborating with Committee II.
6. Investigate and report on methods of improving shunting of track circuits.
7. Investigate and report on means of minimizing effects of stray grounded current and inductive interference from high tension power lines on signal track circuits.
8. Investigate and report on the use of automatic block systems, with superimposed control.
9. Investigate and report on the use of track instruments instead of track circuits for the release of electric switch locks and electric locking.
10. Instructions for operation of drilling machines and drilling of holes for bond application.
11. Specification for high voltage lightning arresters—various voltage ranges.
12. Investigate and report on the practicability of in-service tests of all types of lightning arresters.
13. Instructions for regrinding of bonding drills.
14. Investigate and report on devices for sanding of rail, or equivalent, which will reduce track circuit shunt failures due to sand, collaborating with Mechanical Division, A.A.R.
15. Investigate and report on the various types of power for operating signaling systems and the operating cost therefor.

16. Investigate and report on transposition requirements in erection of signal power lines (joint signal-communication line construction).

17. Develop formulae for calculating energy requirements and line characteristics for a two wire code control line system, collaborating with Committee XI.

18. Performance specification for solderless type connectors for use in wiring signal apparatus (various size conductors).

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Specification 151-42, Manual Part 112.

Revision of Requisites for Electric Locks Applied to Hand-Operated Switches for Protection of Main Track Movements, Manual Part 211.

Revision of Specification 180-39, Manual Part 145.

Revision of Specification 80-44, Manual Part 146.

Revision of Specification 81-43, Manual Part 147.

Revision of Specification 154-39, Manual Part 101.

Revision of Specification 105-39, Manual Part 123.

Revision of Formulae for Computing Minimum Allowable Resistance between Track Battery and Track and for Computing Related Current and Voltage Data, Manual Part 132.

4. Specification 254-49.

5. Specification 249-49.

10. Instructions for Operation of Power Machines and Drilling of Holes for Rail Bonding.

12. Practicability of in-service tests of all types of lightning arresters.

13. Instructions for Resharpening of Twist Drills for Bonding.

15. Use of wind-driven direct current generators for railway signaling.

16. Transposition requirements in erection of signal power lines (joint signal-communication line construction).

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.R.E.A.—American Railway Engineering Association, 59 E. Van Buren St., Chicago 5, Ill.

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.

A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

S.A.E.—Society of Automotive Engineers, 29 W. 39th St., New York 18, N. Y.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

Disposition of 1948 Letter Ballot Subjects

The following subjects presented by this Committee at the 1948 Annual Meeting were submitted to letter ballot and officially approved:

Specification 178-48—Welded Type Rail Head Bonds and Track Circuit Connectors—Now in Manual Part 141.

Specification 179-48—Mechanically Applied Rail Head Type Bonds and Track Circuit Connectors—Now in Manual Part 142.

Requisites for A. C. and D. C. Coded Signal Systems—Now covered in Manual Part 34.

Requisites for Automatic Block Signaling Circuits—Now in Manual Part 34.

Specification 233-48—Voice Pass Filter for Coded System Control—Now in Manual Part 240.

Specification 234-48—Voice and Type H Pass Filter for Coded System Control—Now in Manual Part 241.

Specification 235-48—Voice and Carrier Pass Filter for Coded System Control—Now in Manual Part 242.

Specification 229-48—Selenium Rectifiers—Now in Manual Part 243.

(Revision of A.A.R. Signal Section Specification 151-42)
A.A.R. SIGNAL SECTION SPECIFICATION 151-49.

PLUG TYPE RAIL BONDS AND TRACK CIRCUIT CONNECTORS

*Proposed Revision*7. *Conductors.*

(d) Steel and copper-covered steel wires shall meet the following requirements as to mechanical and electrical properties:

	Galvanized steel wire			Copper-covered steel wire			
Diameter in mils (commercial tolerance allowed).....	109	77	66.1	128	102	88	81
Minimum strength, lbs.....	476	240	215	710	450	335	280
Minimum elongation per cent in 10 in. of each wire in any conductor.....	8	8	8	15	15	15	15
Maximum weight in lbs. per mile-ohm at 68 deg. F.....	6,000	6,000	6,000	2,220	2,220	2,220	2,220

16. *Tests.*

(g) One-half of the samples chosen shall be used for mechanical tests.

2. One sample for each 3,000 or less shall be tested to destruction, the terminals gripped in a tensile machine and uniform stress applied along the axis of the bond. If fracture occurs at the weld, two additional samples shall be similarly tested, and if either of these fails in the weld, the lot shall be rejected. The weld shall be considered satisfactory if a piece of each wire adheres to each terminal.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 7-d and 16-g-2 of Specification 151-42—Plug Type Rail Bonds and Track Circuit Connectors, Manual Part 112.

A.A.R. SIGNAL SECTION SPECIFICATION 254-49.

TWIST DRILLS FOR BOND HOLES

1. *Purpose.*

(a) This specification is for the purpose of providing round shank twist drills to be used with collet chucks for drilling $\frac{3}{8}$ in. holes in the head or web of steel rails to apply bonds and track circuit connectors.

2. *Tender.*

(a) The tender shall be for drills meeting the requirements of this specification in its entirety.

3. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

4. *Dimensions.*

(a) Drill shall be $\frac{3}{8}$ in. nominal diameter, ground to 0.374 point diameter, plus 0, minus 0.0015 in.

(b) Drill shall be 3 in. long, plus or minus $\frac{1}{64}$ in. from extreme end of shank to the full diameter at top of conical point.

(c) Drill shall have a flute length of $1\frac{3}{4}$ in., plus or minus $\frac{1}{16}$ in.

5. *Design.*

(a) Drill shall have flat end round shank $\frac{3}{8}$ in. nominal diameter, ground to 0.374 diameter, plus 0, minus 0.0010 in. for its full length.

(b) Web of drill shall be central.

(c) Drill shall have sufficient back taper to prevent binding in hole.

(d) Manufacturer's name or brand and diameter of drill shall be stenciled in such manner as not to raise any metal above surface of shank.

6. *Grinding.*

(a) Drills shall be carefully ground on precision machines having micrometer adjustment. Drills shall be ground on dry wheels without excess heating so as not to impair the cutting quality.

(b) Point angle shall be 118 deg., plus or minus 3 deg.

(c) The clearance behind the cutting edges at the periphery of the drill shall be 10 deg., plus or minus 2 deg.

(d) Cutting edges shall be 180 deg. apart, at a height not to exceed 0.004 in. difference in the edges of the drill. Cutting edges shall be within 0.014 in. measured on the periphery of the drill from a 180 deg. angle.

7. Packing.

(a) Drills shall be furnished in sets of six, packaged in a cardboard carton. Interior of carton shall have suitable separators so arranged that drills cannot strike each other and to protect against loss or damage but still permit easy removal of any drill.

8. Marking.

(a) Each carton shall be marked with the following information:

1. Name of Manufacturer.
2. Twist drills for bond holes.
3. Diameter and length of drill and type of shank.
4. A.A.R. Signal Section Specification 254.

(b) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of shipping container.

9. Tests and samples.

(a) Tests may be made by Purchaser on samples to be submitted by Manufacturer when specified on order, or upon samples selected from an order that has been received.

(b) When order calls for samples, Manufacturer will withhold balance of shipment until Purchaser advises that drills are acceptable.

(c) Purchaser may specify or select any number of drills from six to a total of 1 per cent of an order as samples for test.

(d) Samples for test are to be selected at random or at direction of Purchaser.

(e) Samples tested, if found to be acceptable, will apply to quantities on order.

10. Acceptance requirements.

(a) Each of the drills selected as samples, when mounted in a rigid upright bench drill press with collet chuck in first-class condition operating between 300 and 325 r.p.m. drill speed and feed per revolution of 0.007 in., shall drill without lubricant, cooling or resharpening not less than 200 holes $\frac{3}{8}$ in. diameter and $\frac{5}{16}$ in. depth in steel having same properties as new A.R.E.A. rail.

(b) Should 10 per cent or more of the drills selected fail to drill 200 holes, or if any of the holes shall exceed 0.380 in. or be less than 0.373 in. diameter, the entire lot may be rejected.

(c) Should the required number of samples meet the requirements for new drills, then 50 per cent of the remaining drills shall be ground or cut off to $2\frac{1}{2}$ in. length. Each resharpened sample shall drill not less than 100 holes under conditions and tests for new drills.

(d) Should 10 per cent or more of the resharpened drills fail to drill 100 holes, or if any of the holes shall exceed 0.380 in. or be less than 0.373 in. diameter, the entire lot may be rejected.

11. *Warranty.*

(a) Manufacturer shall warrant the drills covered by this specification to be free from defects in material and workmanship, his obligation under this warranty being limited to making replacement of drills found defective upon receipt by Purchaser or when lot has been rejected by tests.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION INSTRUCTIONS.

OPERATION OF POWER MACHINES AND DRILLING OF
HOLES FOR RAIL BONDING

1949

Head of rail drilling.

1. Twist drills $\frac{3}{8}$ inch diameter must be used for bond holes.
2. Machine should be adjusted in accordance with manufacturer's instructions so that center line of the hole drilled will be approximately $\frac{3}{8}$ inch above lower edge of rail head to conform to Drawing 1048.
3. Machine (chuck and drill stop) should be adjusted in accordance with manufacturer's instructions so that drilled hole will be a minimum of $\frac{1}{4}$ inch and a maximum of $\frac{5}{16}$ inch in depth to conform to Drawing 1048.
4. Indicator on machine, if so equipped, should be adjusted to locate hole or holes with respect to rail end.
5. Machine must be clamped on rail so that indicator point is in line with rail end before drilling hole or holes. Single spindle machine should be shifted on rail so that opposite indicator is in line with opposite rail end before clamping machine and drilling second hole.
6. Holes should be drilled at right angles to surface to be drilled, unless otherwise instructed for special shapes of rail.
7. Machines provided with adjustable level should be adjusted in accordance with manufacturer's instructions.
8. Rail clamps must be kept in adjustment to insure that machine is securely clamped to rail while drilling is in progress.
9. Pressure should be applied on feed lever until depth stop comes in contact with rail head. This position can be observed and is indicated by speeding up of engine.
10. Machine should be adjusted to rotate the drill, when under load, at a speed not to exceed 250 r.p.m. When drilling end hardened rail, it may be necessary to reduce drill speeds to 200 r.p.m. or lower. Speed should be checked occasionally with a speed indicator. If machine cannot be adjusted to operate at these speeds, repairs to engine may be necessary.
11. Holes must be drilled dry, chips removed, and checked frequently with plug gage, Drawing 1048, for diameter and depth, and immediately after changing drill.
12. When drills are changed, machine must be readjusted as covered in Instruction 3.
13. Drills operating with good cutting efficiency will cut two equal shavings or chips with no excessive noise. Drills which do not cut a properly sized hole, or which do not cut efficiently, must not be used. Such drills must be re-sharpened on a precision grinder, before further use.

Web of rail drilling.

14. Holes should be drilled in the direction in which bond terminal is to be driven.

Web of rail drilling.—Continued.

15. Machine should be so adjusted that hole will be drilled approximately midway between base and head of rail and as close to splice bar as practicable.

16. Machine should be operated in same manner as for drilling head of rail. Pressure on feed lever should be reduced when drill point perforates the opposite side of rail.

17. Lubricant for drills may be used when drill perforates the rail.

Preparation of machine for use.

18. Before operating machine it must be thoroughly cleaned and engine crank case, gear case and air cleaner must be filled to proper level with the recommended oils.

19. Engine crank case and air cleaner must be kept filled to required level at all times in accordance with manufacturer's instructions, using the approved SAE weight and grade of oil recommended for the prevailing temperature under which machine is to be operated.

20. Clean non-leaded gasoline must be used. Fuel tank must not be filled while engine is running. Avoid spilling gasoline on hot engine as this may cause an explosion and serious injury. Oil must not be mixed with gasoline supply for four stroke cycle type engines.

21. All moving parts should be lubricated in accordance with manufacturer's instructions.

22. Engine and all moving parts must be kept clean both inside and outside and protected so that no dirt or water enters crank case, air cleaner, fuel tank or gear case when opened for inspection or refilling.

23. When machine is off the rail, it must be placed so that drill bit, chuck and spindle housing will not come in contact with grit or dirt.

24. Machine should be kept adjusted in accordance with manufacturer's instructions.

Regular servicing of machine.

25. Engine crank case and air cleaner must be drained and refilled after each 25 hours of engine operation. Never flush engine crank case with kerosene.

26. Gear case must be kept filled at all times with transmission grease of grade recommended by manufacturer (or equivalent). It should be cleaned out with gasoline and refilled regularly, dependent upon use.

Storing of machine.

27. Machine stored for any length of time should be completely drained of fuel to prevent gum deposits forming on essential parts such as the carburetor, fuel filter, fuel lines and fuel tank. The following action should be taken before storing:

- (a) Remove filter bowl, open shut-off valve and drain fuel tank completely.
- (b) Operate engine until it stops from exhaustion of fuel.
- (c) Replace filter bowl.
- (d) Leave shut-off valve open.
- (e) Remove spark plug, pour not more than 1 ounce of SAE No. 20 oil into cylinder and crank engine slowly to spread oil. Replace spark plug.

Storing of machine.—Continued.

(f) Exposed portion of spindle and other revolving parts must be coated with a light coating of cup grease or vaseline, and preferably wrapped to prevent corrosion.

28. Machine must be stored in a weatherproof housing and covered with canvas to keep machine clean.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION INSTRUCTIONS.

RESHARPENING OF TWIST DRILLS FOR BONDING

1949

1. All used drills should be resharpened, preferably at one or more central points, on a precision machine having micrometer adjustment.
2. Grinding wheels should be of aluminum oxide abrasive, 60 grain size and M grade. Wheels must be maintained in surface by use of a proper wheel dressing tool.
3. Drills should always be resharpened on dry wheels and never dipped in any cooling agent.
4. Care must be taken when resharpening drills to avoid overheating to the extent that drill becomes discolored. Drill point must not be forced against grinding wheel since too rapid removal of the metal will overheat the drill and damage grinding wheel surface.
5. Drills should be resharpened to point angle of 118 degrees with lip clearance of 10 degrees.
6. Drills should be ground only to a point where lands or blades are not worn appreciably, as indicated by visual inspection or micrometer measurement.
7. Web of drill should be thinned by grinding until chisel point is approximately 12 per cent of full diameter.

Action Recommended

Acceptance for submission to letter ballot.

USE OF WIND-DRIVEN DIRECT CURRENT GENERATORS FOR RAILWAY SIGNALING

Several types of wind-driven direct current generators to charge storage batteries are available and have been in use for about 12 years. Satisfactory use and the economy depend upon geographical location and the purpose for which used.

Generally they are used in remote locations where no alternating current power is available and primary battery power is too costly. For satisfactory use there must be sufficient prevailing wind to produce adequate charging rates. While a number of installations are in service, reports from two railroads will serve as examples of application:

One railroad operating into the northwest territory reports 27 installations in service: 1 in Minnesota, 23 in South Dakota and 3 in North Dakota, installed during the years 1941 to 1947. Of these installations, 5 are for charging a 10-volt storage battery for flashing light signal operation and the other 23 installations for charging a 26-volt split storage battery (16 and 10) used in connection with automatic block signal system controlled by a code system.

Another railroad operating into the north central states reports 3 installations in service: 1 in Iowa and 2 in Illinois, installed during the years of 1940 and 1943, for the charging of storage batteries at remote flashing light signal locations.

One type of installation for highway crossing protection consists of a 12-volt generator with 31-inch governor operated brake to control the speed of a two-blade propeller each 3 feet long. It is mounted on a 5-foot tapered stub tower erected on a wood pole to obtain about 30 feet in height. This height is necessary to pick up the wind force and also prevent malicious interference by trespassers. The generator requires an 8-mile wind to start charging and delivers a maximum charge of 6 to 7 amperes in a 20-mile wind. On this installation, the storage battery is 160 ampere-hour capacity. A 670-ohm relay is arranged to operate on one coil with a 500-ohm resistance unit in series with it, the other coil disconnected. The relay picks up on 9.10 volt, 0.0109 ampere and releases on 5.59 volts, 0.0067 ampere.

If for any reason the storage battery should become exhausted to a point where it would no longer properly operate the signals, the heavy lamp load would reduce the voltage to the release value of the transfer relay which would then cut in the primary stand-by battery, which consists of 18 cells, to insure that the voltage would be approximately the same as that of the storage battery.

The installation described above was installed in 1940. The installation cost at that time was \$178 and net annual savings were approximately \$136, or 76 per cent. The performance has been entirely satisfactory and subsequent installations of the same general type have been made on this railroad.

Other installations for charging of storage batteries for highway crossing signals have been in service since 1940, 1941 and 1943. By being able to use storage battery instead of primary battery power, an annual saving of \$90 on a \$400 investment, or 22 per cent, was made.

At some of these remote locations, the transportation and availability of water for primary battery renewal was of some consideration.

Another type of installation for a location of controlled automatic block signals consists of a 32-volt generator, 1,800 watt capacity, mounted on a 50-foot 4-leg steel tower complete with automatic controls for charging a 16-volt and a 10-volt split storage battery group. It is equipped with a fly ball governor which automatically controls the pitch of the blades. When the wind velocity exceeds 20 to 25 miles per hour, the governor changes the pitch of the three 14-foot propeller blades so that the pressure exerted at 60 miles an hour or higher is the same as it would be at 20 or 25 miles an hour. Installations of this type were made because the cost of securing and distributing commercial power was prohibitive and the use of primary battery power too expensive.

The necessity for controlling the wind pressure is of more importance than the speed on a plant of this type. The pressure exerted at 65 miles an hour can reach 2,000 lbs. which would wreck a plant of this type. There are several methods of controlling the speed but there is only one way of controlling the pressure and that is by changing the blade pitch so that the exposed area is reduced.

Some difficulties were experienced with the automatic controls on the first installations due to the perplexities of the split battery layout. Subsequent experience has brought about changes to overcome these difficulties.

There have been only one or two occasions when an extended calm was of sufficient period to allow the storage battery to exhaust. This condition, of course, will vary with the geographical location and consideration should be given to larger capacity storage batteries, primary battery stand-by or portable gasoline operated generators for use in emergency.

The use of wind-driven generators is not to be recommended where reliable alternating current power is available; however, experience in some of the remote sections of the northwest territory has proven the wind plant as a more reliable source of power than the commercial alternating current available.

Increased maintenance over the customary floating charge system is to be expected because of the higher rates at which the batteries are charged; they require more attention and much more water. The maintenance of the wind plant as compared to the periodic renewal of primary battery for a relative heavy power load would be considerably less in most cases.

Some additional hazards exist for employees such as the necessity to climb the towers to break ice accumulation from the propeller blades.

The Committee is of the opinion that wind-driven generators can be used at selected remote locations and will produce more satisfactory results with savings over other power arrangements that might be available. An individual study should be made for each location and application.

One of the wind generator manufacturers has stated that a rough way of judging whether the wind generator can be expected to give satisfactory service is to consider its use only in those areas where the wind blows 60 to 70 per cent of the time at an average velocity of at least 40 per cent of the maximum velocity characteristic of that area. It is desirable, however, that this preliminary judging should be supported by actual field check.

Action Recommended

Acceptance as information.

(Revision of Requisites for Electric Locks Applied to Hand-Operated
Switches for Protection of Main Track Movements)
A.A.R. SIGNAL SECTION REQUISITES.

ELECTRIC LOCKS APPLIED TO HAND-OPERATED SWITCHES FOR PROTECTION OF MAIN TRACK MOVEMENTS

1949

Proposed Revision

6. Electric locks may unlock to permit train or engine to enter main track by either of the following:

(b) After signal control circuits have been opened and after the expiration of a time interval determined in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Requisite 6-b of Requisites for Electric Locks Applied to Hand-Operated Switches for Protection of Main Track Movements, Manual Part 211.

(Revision of A.A.R. Signal Section Specification 180-39)
A.A.R. SIGNAL SECTION SPECIFICATION 180-49.

DETACHABLE TYPE NEUTRAL DIRECT CURRENT RELAY FOR NON-VITAL CIRCUITS

1. *Purpose.*

(a) This specification is for the purpose of providing a quick detachable tractive armature direct current neutral relay for use in non-vital circuits of signal systems. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *Design.*

(a) Relay shall be of a design approved by the Purchaser.

1. Relay shall be of the quick detachable type.

(b) A typical basic relay structure meeting this specification shall operate its armature through the full stroke to its stop at an energization of not more than 200 ampere turns, when equipped and adjusted as follows:

1. Four dependent front and back contacts.

2. An armature motion to provide for the following contact performance with a minimum physical working air gap of 0.005 in. total.

(a) Not less than 0.025 in. compression on each front and back contact.

(b) Not less than 30 grams total pressure for each contact spring.

(c) Not less than 0.010 in. front or back contact opening when other contact is just closed.

(c) Relay shall be furnished with contacts as required.

1. All contact springs shall have multiple contact tips except when carbon or special metal contacts are required for heavy duty.

5. *Design.*—Continued.

2. Contact springs having multiple contact tips shall be split with the exception that the heel spring need not be split when the associated front or back contact member is a split flexible contact spring. (A heel contact spring is defined as a contact spring that is actuated directly by movement of the armature.)

3. Contact heel springs shall be biased to exert force on relay armature toward its de-energized position.

4. Contact stacks with more than one heel spring may be operated by insulating pushers.

5. All free flexible contact members (members not actuated directly by the moving armature) shall be provided with stops.

6. Contacts shall be readily visible and accessible from the front of the relay.

(d) Relay shall be designed to operate at least 36,000,000 times without developing defect, under normal conditions of service and in circuits prescribed by the Manufacturer.

(e) Case, when provided, shall adequately protect the relay or relays from dust or mechanical interference and be adapted for sealing.

(f) All nuts and screws shall be securely locked.

6. *Mounting.*

(a) Contacts shall be rigidly supported by molding in bakelite or stacked in molded phenolic insulating material in a manner that will preclude the contacts or the contact assembly becoming loose in service.

(b) Core, armature and fixed contacts shall be so mounted that their proper operative relationship shall be maintained.

7. *Armature supports.*

(a) Armature shall be so mounted as to insure free operation throughout its stroke.

8. *Air gap.*

(a) Where stop pins are required for control of armature air gap they shall be of hard-drawn bronze, non-magnetic stainless steel or bakelite. If bakelite is used it shall be of such composition and proportions as to insure no appreciable change in shape or dimensions under ordinary conditions of moisture or between 40 deg. F. below zero and 185 deg. F. above zero.

9. *Coil insulation.*

(a) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.



9. *Coil insulation.*—Continued.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(c) Coils adjacent to moving parts, armature air gaps or contacts shall be treated by impregnation or dipping with insulating varnish in accordance with Requisites for Varnish for Treatment of Electrical Windings, Manual Part 174.

(d) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum wall thickness of $\frac{1}{16}$ in.

(e) Insulating material used for fillers in winding coils shall be chemically neutral.

(f) Wire for coils shall be connected direct to spring contact terminals mounted in bakelite, or terminal leads of coils shall be made of flexible wire, properly insulated.

(g) Coils shall be so insulated that they will withstand the insulation test provided in section 14. This test shall be made by mounting coil on a snugly fit metal mandrel and making breakdown tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

10. *Contacts.*

(a) Contact elements shall be so secured that they will not shift nor become loose in shipment or service.

(b) Material used in affixing contact elements must not cause corrosion.

(c) For contacts of the metal to metal type, the initial cleaned contact resistance shall not exceed 0.030 ohm per contact.

11. *Operating characteristics.*

(a) Operating characteristics shall be established by the Manufacturer and data furnished for each relay or assembly of relays as required.

(b) The temperature rise, as measured on coils requiring continuous energization, shall not, at maximum operating voltage, exceed 100 deg. F., determined by resistance method.

12. *Finish.*

(a) Metal parts other than contact springs shall be protected against corrosion by nickel plating per A.S.T.M. current Speci-

12. *Finish.*—Continued.

fication B 141 Type Q.C., or chromium plating, per A.S.T.M. current Specification B 177, or the equivalent, except where such protection may interfere with proper operation of the relay. Zinc or cadmium shall not be used except as an undercoat for dual plating.

(b) Material used for protection against corrosion shall neither melt nor flake under ordinary conditions between temperatures of 40 deg. F. below zero and 185 deg. F. above zero.

13. *Insulation.*

(a) Material used as insulation, including coil heads, shall be free from warpage or appreciable expansion or contraction due to moisture or by change in temperatures between 40 deg. F. below zero and 185 deg. F. above zero. If molded and other than porcelain, it shall, when made up in a standard A.S.T.M. test piece 0.125 in. thick by 4 inches in diameter, meet a requirement of 300 volts per mil. Test shall be in accordance with A.S.T.M. current Specification D 48.

14. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

(b) A surface leakage distance of not less than $\frac{1}{8}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

15. *Identification.*

(a) Relay shall be plainly marked with Manufacturer's reference number.

16. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

17. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

18. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

19. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

20. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 180-39—Centralized Traffic Control Detachable Type
Neutral Direct Current Relay, Manual Part 145.

(Revision of A.A.R. Signal Section Specification 80-44)
A.A.R. SIGNAL SECTION SPECIFICATION 80-49.

COLOR LIGHT SIGNAL, DOUBLET LENS TYPE

1. *Purpose.*

(a) This specification is for the purpose of providing color light signal units of the doublet lens type. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

(b) Signal units for long range with $8\frac{3}{8}$ in. diameter lenses and also for short range and dwarf signals with $6\frac{3}{8}$ in. diameter lenses are covered by this specification.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) The general design, dimensions and structure of signal shall conform to Purchaser's drawing.

(b) Detail design of signal shall be approved by Purchaser.

(c) Like parts of same Manufacturer's apparatus shall be interchangeable.

7. *Signal case and electric light units.*

(a) Signal case shall be cast iron, weatherproof, and shall be equipped with suitable door or cover having a hasp lug with a minimum opening of $\frac{1}{2}$ in. for application of a lock. The door or cover when open shall permit easy access to all parts.

(b) The door or doors of the signal case shall be so arranged

7. Signal case and electric light units.—Continued.

that, when left open, daylight from the back of the signal will not cause a less restrictive indication than that intended to be displayed.

(c) Electric light units shall, in so far as practicable, be of such design and construction as to prevent undesirable reflection of external light.

(d) Assembly of electric light units to signal case for long range shall be so designed that the projected light beams from all units in one signal case will be parallel to each other.

(e) Case for long range units shall be provided with means for use of a sighting device accurately aligned parallel to the projected light beams.

(f) Means shall be provided on long range cases for the addition of special wide angle deflecting prism roundels to improve visibility of signal on specified curves.

(g) Signal case shall display one, two or three colors as specified by the Purchaser, and with colors provided and arranged as specified for vertical, horizontal or triangular assembly.

(h) Conduit of single strip flexible type shall be provided for protection of electrical connections entering cases of the bracket mounted type. *R-7-h.

1. Wire entrance in case shall have edges rounded and be readily accessible for sealing.

2. Conduit shall be equipped with means for making a good mechanical connection to mast and case.

(i) Means shall be provided for the addition of a device for suppression of phantom indications.

8. Electric lamps and receptacles.

(a) Electric lamps shall be in accordance with Specification 51, Manual Part 91, and shall be low-voltage with filament located to $\frac{1}{64}$ in. precision for long range signals.

(b) Rating of lamps shall be as specified by Purchaser.

(c) Lamp receptacles for long range units and for low-voltage $\frac{1}{64}$ in. precision lamps in short range signals shall be accurately located and rigidly held in place and sealed relative to their respective lens assemblies. *R-8-c.

(d) Lamp receptacles in short range signals for other than $\frac{1}{64}$ in. precision lamps shall be located as accurately as practicable and shall not be sealed relative to their respective lens assemblies.

9. Backgrounds and hoods.

(a) Backgrounds shall be provided for each signal case, except dwarf signals, made of copper-bearing sheet steel not less than 0.0375 in. thick when braced, or 0.0781 in. when not braced. The outer edge shall come not closer than 12 in. to the center of

* Alternate requisites section.

9. *Backgrounds and hoods.*—Continued.

lens units, except for single units having circular backgrounds, the diameter shall be not less than 20 in.

(b) A hood shall be provided for each lens assembly, made of copper-bearing sheet steel not less than $10\frac{1}{2}$ in. long for long range signals, 7 in. long for short range signals, or 4 in. long for dwarf signals, extending more than half-way around the lens opening.

(c) Hood shall be designed to minimize the likelihood of snow or ice accumulating on the lens or roundel.

10. *Lenses and roundels.*

(a) Lenses and roundels shall be in accordance with Specification 69, Manual Part 136.

(b) Lenses shall be of the doublet type, outer lens clear optical, $8\frac{3}{8}$ in. diameter for long range, $6\frac{3}{8}$ in. diameter for short range and dwarf signals; inner lens colored as required, $5\frac{1}{2}$ in. diameter. The focal length of the combination shall be $\frac{1}{2}$ in.

11. *Range.*

(a) Range shall be the distance on a tangent at which, under bright sunlight conditions, with the sun at or near the zenith, the indications will be clear and distinct to a person with normal vision.

(b) Range shall be determined with signal equipped with electric light units of horizontal angle of visual spread specified in section 12-b.

(c) Range for electric light units with $8\frac{3}{8}$ in. lens shall be not less than 3,500 ft. when lighted with a 10-volt, 18-watt single filament lamp of 1,500 hours life at rated voltage, burning at 9 volts.

(d) A satisfactory close-up signal indication shall be given.

12. *Spread.*

(a) The angle of spread is defined as the angle included by that portion of the beam within which the intensity of the beam is not less than 50 per cent of the candlepower of the axial beam.

(b) The angle of spread for electric light unit with $8\frac{3}{8}$ in. lens with a 10-volt, 18-watt single filament lamp shall be not less than 2 deg.

13. *Back lights.*

(a) Back lights, if used, conforming to Purchaser's drawing, shall be provided as specified.

(b) Back lights shall be of such design as not to affect the indication of the signal.

14. *Mounting.*

(a) Mounting shall be either top-of-mast or bracket type, bolted to the mast as specified.

14. *Mounting.*—Continued.

(b) Mounting of long range signal cases shall be adjustable, with means provided to establish easily and accurately an independent horizontal and vertical adjustment for alignment of the projected beam.

15. *Terminal boards.*

(a) Terminal board shall be so located as to be easily accessible and shall have binding posts in accordance with section 18.

16. *Transformers.*

(a) Transformers mounted within and forming a part of the signal shall be in accordance with Specification 83, Manual Part 164.

(b) Transformers shall be provided with taps to properly adjust lamp voltage.

17. *Wire and wiring.*

(a) Insulated wire shall be in accordance with Specification 111, Manual Part 186.

(b) Stranded insulated wire not less than No. 18 A.W.G. or solid copper wire not less than No. 14 A.W.G. shall be used for wiring signals.

(c) Wiring shall be neatly arranged and securely fastened.

(d) All wiring shall terminate at binding posts.

18. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, 107020, or soldered terminals, shall be used where no field wires are connected thereto.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

19. *Insulation.*

(a) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions.

20. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom, except the lamp receptacle which shall withstand for one minute an insulation test of 800 volts a.c.

20. *Dielectric requirements.*—Continued.

(b) With the exception of the lamp receptacle, a surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

21. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

(b) Finish coat of non-reflecting black, in accordance with Specification 214, Manual Part 221, shall be applied to the inside and to the front exposed iron and steel part of the signal case and lens assemblies.

(c) Hoods and backgrounds shall be painted with a first coat of red lead primer, or equivalent, and with a finish coat of non-reflecting black, in accordance with Specification 120, Manual Part 110.

22. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

23. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

24. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

(Revision of A.A.R. Signal Section Specification 81-43)
A.A.R. SIGNAL SECTION SPECIFICATION 81-49.

POSITION LIGHT SIGNAL

1. Purpose.

(a) This specification is for the purpose of providing a position light signal. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. Drawings.

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. Tender.

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. Alternates.

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. Material and workmanship.

(a) Material and workmanship shall be first-class in every respect.

6. Design.

(a) The general design, dimensions and structure of signal shall conform to Purchaser's drawings.

(b) Detail design of signal shall be approved by Purchaser.

(c) Like parts of same Manufacturer's apparatus shall be interchangeable.

7. High signal.

(a) High signal shall be a combination of electric light units, the main and auxiliary groups of which shall have the units located on an 18 in. radius about a central unit.

(b) Electric light units shall be mounted on a framework to provide the aspects as specified.

(c) Electric light units shall be mounted in such a way that they may be adjusted individually in order to procure the alignment which will provide satisfactory signal indications.

8. *High signal framework and backgrounds.*

(a) Framework shall be made of iron pipe, not less than $1\frac{1}{4}$ in. inside diameter.

(b) Main group of electric light units shall be provided with background designed to provide for maximum number of units. Unused spaces for units shall be covered with a suitable metallic plate which may be readily removed.

(c) Background for auxiliary group of electric light units shall be provided as specified on Purchaser's drawing.

(d) Background shall be made of copper-bearing sheet steel of a thickness not less than $\frac{3}{64}$ in. The outer edges shall not come closer than 8 in. to the center of an electric light unit.

9. *High signal electric light units.*

(a) Electric light unit cases shall be cast iron, weatherproof, and shall be equipped with suitable doors or covers. The doors or covers, when opened, shall provide easy access to all parts.

(b) The doors or covers of electric light units shall be so arranged that, when left open, daylight from the back of the signal will not cause a less restrictive indication than that intended to be displayed.

(c) Electric light units shall be of such design and construction as to prevent undesirable reflection of external light.

(d) Electric lamp receptacles shall be accurately located and rigidly held in place.

10. *Terminal box for high signals.*

(a) Each group of electric light units shall be provided with a weatherproof cast-iron terminal box.

(b) Wires from electric light units shall be brought to terminals in the terminal box as shown on wiring diagram which is to be located in a conspicuous place in the box.

11. *Dwarf signal.*

(a) Dwarf signal case shall be cast iron, weatherproof, and shall be provided with the maximum number of electric lamp compartments.

(b) Electric lamp compartments shall be separated by light-proof barriers.

(c) Dwarf signal shall be so arranged as to provide the aspects specified. Unused lens openings shall be covered with waterproof cover of same material as case, secured in place by same method as is used for securing lenses and hoods.

(d) Terminal blocks shall be provided and so located as to be easily accessible.

(e) Electric lamp receptacles shall be accurately located and rigidly held in place.

12. *Electric lamps.*

(a) Electric lamps shall be in accordance with Specification 51, Manual Part 91.

(b) Rating of electric lamps shall be as specified by Purchaser.

13. *Hoods.*

(a) A hood shall be provided for each lens.

(b) Hoods for high signals shall be made of copper-bearing sheet steel and shall be not less than $10\frac{1}{2}$ in. long and shall extend more than half-way around the lens opening.

(c) Hoods for dwarf signals shall be made of cast iron and shall be not less than 5 in. long, and shall extend half-way around the lens opening. *R-13-c.

(d) Hood shall be designed to minimize the likelihood of snow or ice accumulating on the lens or roundel.

14. *Lenses and roundels.*

(a) Lenses and roundels shall be made in accordance with Specification 69, Manual Part 136.

(b) Lenses and roundels for high signals shall be $5\frac{3}{8}$ inches in diameter and designed for suitable close-up indication.

(c) Lenses for dwarf signals shall be 4 inches in diameter, standard optical clear $2\frac{1}{4}$ in. focal length, behind which is mounted a 4 in. diameter, 20 deg. clear flat spreadlight roundel, sand-blasted on the side next to the lens.

15. *Roundels for high signal.*

(a) Each electric light unit for a high signal shall have a roundel of "no-glare" yellow tint, $5\frac{3}{8}$ inches in diameter and of such shape as to minimize undesirable reflection of external light.

16. *Range.*

(a) Range shall be the distance on a tangent at which, under bright sunlight conditions, with the sun at or near the zenith, the indications will be clear and distinct to a person with normal vision.

(b) Range shall be determined with signal equipped with lens and roundels of horizontal angle of visual spread specified in section 17-b.

(c) Range shall be as specified, with electric lamp burning at specified percentage of rated voltage.

(d) A satisfactory close-up signal indication shall be given.

17. *Spread.*

(a) The angle of spread is defined as the angle included by that portion of the beam within which the intensity of the beam is not less than 50 per cent of the candlepower of the axial beam.

(b) The angle of spread shall be as specified.

* Alternate requisites section.

18. *Marker lights.*

(a) Marker lights conforming to Purchaser's drawing shall be provided as specified.

(b) Mounting for marker lights shall be as shown on Purchaser's drawing.

(c) Electric light unit for marker lights shall be the same as for high signal.

19. *Mounting.*

(a) Mounting of signal shall be adjustable, with means provided to establish easily and accurately a correct alignment with the track.

20. *Wire and wiring.*

(a) Insulated wire shall be in accordance with Specification 111, Manual Part 186.

(b) Stranded insulated wire not less than No. 18 A.W.G. shall be used for wiring dwarf signals, and solid insulated wire not less than No. 14 A.W.G. shall be used for wiring high signals.

(c) Wiring shall be neatly arranged and securely fastened.

(d) All wiring shall terminate at binding posts.

21. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010, for field wire connections.

(b) Binding posts, nuts and washers conforming to Drawing 1070, assembly 10705, or 107020, or soldered terminals, shall be used where no field wires are connected thereto.

(c) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts.

(d) Binding posts shall be spaced not less than 1 in. centers.

22. *Insulation.*

(a) Material used for insulation shall be such as will not be injuriously affected by atmospheric conditions.

23. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom, except the lamp receptacle which shall withstand for one minute an insulation test of 800 volts a.c.

(b) With the exception of the lamp receptacle, a surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

24. Paint and painting.

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110.

(b) A finish coat of non-reflecting black, in accordance with Specification 214, Manual Part 221, shall be applied to all exposed metallic front parts of electric light units.

(c) A finish coat of non-reflecting black, in accordance with Specification 214, Manual Part 221, shall be applied to the inside of electric lamp compartment of dwarf signals.

(d) Hoods and backgrounds shall be painted with a first coat of red lead primer, or equivalent, and with a finish coat of non-reflecting black, in accordance with Specification 120, Manual Part 110.

25. Inspection.

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

26. Tests.

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

27. Packing.

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

28. Marking.

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

28. *Marking.*—Continued.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

(c) Where carload shipments are made, name and address of Consignee may be omitted.

29. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-13-c.

Hoods for dwarf signals shall be made of copper-bearing sheet steel and shall be not less than in. long.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 81-43—Position Light Signal, Manual Part 147.

A.A.R. SIGNAL SECTION SPECIFICATION 240-49.

IMPULSE TRANSFORMER FOR CODED SYSTEM CONTROL

1. *Purpose.*

(a) This specification is for the purpose of providing an impulse transformer for transforming direct current line current changes into voltages of proper polarity, during indication codes, to operate polar or polar biased relays at office and remote carrier locations in a multiple type line coded control system. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Purchaser's order.*

(a) Purchaser's order shall specify the type of coded control system for which the transformer is desired.

(b) Purchaser's order shall specify by drawings or otherwise the line wire and controlled station arrangement for new installations on which the transformer is to be used.

7. *Design.*

(a) Transformer shall be of a design approved by the Purchaser.

(b) Transformer shall be designed for indoor service.

(c) Transformer shall be designed for wall and shelf mounting.

7. *Design.*—Continued.

(d) Transformer shall be totally enclosed in a case which shall be designed to protect the windings and leads from the windings to the terminal board. *R-7-d.

8. *Windings.*

(a) The primary shall consist of two separate windings, one for each side of the line. *R-8-a.

(b) The d.c. resistance of the windings shall be such as to insure satisfactory performance of the system in which the impulse transformer is used.

(c) Separate windings shall be insulated from each other.

(d) The temperature rise determined by the A.S.A. standard resistance method shall not exceed 99 deg. F. above room temperature with 0.5 ampere flowing through the primary windings in series.

9. *Polarity of windings.*

(a) The instantaneous external polarities of windings shall be indicated by plainly marking the relative positive and negative leads from each winding. They shall be determined as follows:

1. The positive leads of the primary windings shall be arbitrarily indicated.

2. The positive lead of the secondary winding will then be that lead from which current is flowing out to the load at the instant when current is flowing into the positive terminal of the primary winding with a suitable alternating voltage applied to the primary.

(b) All transformers of a given type and manufacture shall be so arranged that the instantaneous polarities of corresponding leads are alike.

10. *Insulation.*

(a) Windings shall be made with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(b) Windings shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171. *R-10-b.

* Alternate requisites section.

11. Core.

(a) The core shall be non-aging laminated sheet steel so assembled that no buzzing is perceptible when a suitable 60-cycle voltage is applied to the primary windings in series.

(b) The steel shall be considered non-aging provided the change in core loss does not exceed 2 per cent after subjecting the steel to a continuous temperature of 212 deg. F. for a period of 30 days.

12. Windings and core assembly.

(a) The windings and core assembly shall be such as to provide an electrically balanced line when the primary windings form part of a line circuit used by other services on the code line.

(b) The reactance of the winding and core assembly shall be such as not to adversely affect d.c. line current changes during indication codes.

13. Terminal board and leads.

(a) Transformers shall be provided with terminal boards for external wire connections made of molded insulation, ebony asbestos wood or other equally suitable material of thickness sufficient to prevent warping or damage in shipment.

(b) Terminal boards shall be so located as to be easily accessible.

(c) Leads shall be suitably insulated and be brought to binding posts uniformly arranged on the terminal board.

(d) Binding posts shall be clearly marked for primary and secondary, and for polarity, and should agree with the lead marking specified in section 9.

(e) Where winding conductor is of smaller cross-section than No. 18 A.W.G., a flexible conductor of a conductivity not less than that of No. 18 A.W.G. and suitably insulated shall be used between winding and binding post.

14. Binding posts.

(a) Binding posts, nuts and washers shall conform to Drawing 1070, detail 107010.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts, and spaced at not less than 1 in. centers.

15. Dielectric requirements.

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom.

15. *Dielectric requirements.*—Continued.

(b) A surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

(c) Separate windings, which are insulated from each other, shall withstand for one minute an insulation test of 3,000 volts a.c. between their terminals.

(d) The separate windings when set up in a bridge type measuring circuit shall be free from short circuits as indicated by the balance of the bridge.

16. *Identification.*

(a) Transformer shall include a name plate, securely fastened, giving the following information:

1. Name and address of Manufacturer.
2. Type of transformer.
3. Manufacturer's reference number.
4. Serial number.

17. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

18. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

(e) The following tests may be required by Purchaser on all impulse transformers:

1. Transformers shall be connected in the equivalent coded control circuit for which they were designed. The

18. *Tests.*—Continued.

Manufacturer will provide the circuit in which the standard units, filters and relays used in the system are to be connected for the transmission of code. An operating test shall be made from which it will be determined that with transformers in the circuit, code operation is satisfactory throughout the line battery voltage limits which may exist in service.

19. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

20. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment.

21. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-7-d.

Transformers shall be of the non-enclosed type.

R-8-a.

Transformer primary shall consist of a single winding.

R-10-b.

Windings shall be treated by impregnation or dipping with insulation varnish in accordance with Requisites for Varnish for Treatment of Electrical Windings, Manual Part 174.

Action Recommended

Acceptance for submission to letter ballot.

TRANSPPOSITION REQUIREMENTS IN ERECTION OF
SIGNAL POWER LINES (JOINT SIGNAL-COMMUNICATION
LINE CONSTRUCTION)

This report on transposition requirements is based on the assumption that standard practices, prescribed in proposed A.A.R. Communications Section Specification for the Joint Use of Poles for Power, Communication and Signal Circuits on Railroad Property, will be followed in the construction of joint lines.

A single-phase power circuit generally requires no transpositions if its voltage does not exceed 550, its transmitted power does not exceed 3,200 watts, and it is carried on the end and adjacent pins of the lowest cross-arm which is located not less than 2 feet below the lowest communication wires or cable on the line.

Power lines carried above communication circuits and having the following characteristics generally require no transpositions:

(a) Constant potential alternating current supply circuits normally operating at not exceeding 5,000 volts between conductors or 2,900 volts to neutral or ground.

(b) Constant current supply circuits of not more than 7.5 amperes regardless of the voltage, and of more than 7.5 amperes where the open circuit voltage of the supply transformer is not more than 2,900 volts.

Note.—Joint use construction involving constant potential alternating current supply circuits above 5,000 volts between conductors or more than 2,900 volts to neutral or ground and constant current supply circuits of more than 7.5 amperes where the open circuit voltage of the supply transformer is more than 2,900 volts is considered special joint use and should be undertaken only after careful joint consideration and approval of all concerned.

Transpositions in the communication circuits are designed to provide adequate protection from metallic circuit induction.

If induction from the power line is encountered, transposition of the signal power line should be made at the mile points of the communication transposition scheme. Another method which has been used for signal power lines, and which has proven effective in reducing the induction in the communication circuits, is to treat the signal power line, so far as its transpositions are concerned, as if it were a communication circuit. If the desired neutralization is not obtained, a special joint study of the communication, power and signal circuits will be necessary.

Generally signal power lines up to and including 6,600 volts have been carried on top of joint pole lines without transpositions in the signal power line. Since the wattage is very low, discontinuities of the power line are few and no inductive interference is experienced under normal operating conditions. Should induction from power line be encountered, coordinated transpositions of the signal power and communication circuits should be made in accordance with Specification 1-D-1 of the Communications Section, A.A.R.

Action Recommended

Acceptance as information.

(Revision of A.A.R. Signal Section Specification 154-39)
A.A.R. SIGNAL SECTION SPECIFICATION 154-49.

TRACTIVE ARMATURE DIRECT CURRENT NEUTRAL RELAY WITH TWO CONTACT FINGERS

Proposed Revision

1. *Purpose.*

(a) This specification is for the purpose of providing a tractive armature direct current neutral relay, first voltage range, requiring low operating power, suitable for series line approach lighting, and vital circuits other than track circuits. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

10. *Coils.*

(b) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(c) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(d) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum thickness of $\frac{1}{16}$ in.

(e) Insulating material used for fillers in winding coils shall be chemically neutral.

(f) Coils shall be so insulated that they will withstand the insulation test provided in section 14. This test shall be made by mounting coil on a snugly fit metal mandrel and making breakdown tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

(g) Connecting terminals of coils shall be joined either by a 14-24 or 10-32 binding post. Terminal leads of coils shall be of strands of tinned copper not larger than No. 28 A.W.G. wire. The aggregate cross-section of the strands shall at least equal

10. *Coils.*—Continued.

that of No. 18 A.W.G. wire. Leads shall be so insulated that they will withstand the insulation test provided in section 14.

(h) The coil terminal wires from the ends of the coil closest to the cores shall be used as lead wires.

(i) Coils shall be protected in a suitable manner from mechanical injury.

(j) At 68 deg. F. the percentage of variation in the resistance of individual coils shall not exceed:

1. For 5 ohms or less, plus or minus 5 per cent.
2. Above 5 ohms, plus or minus 10 per cent.

(k) Each coil shall be plainly and permanently marked, showing the Manufacturer's reference, nominal resistance, number of turns, size of wire and kind of wire insulation on a tag of non-conductive material adjacent to the outside lead.

(l) All coils shall be full-wound and the number of turns shall not be permitted to vary more than 5 per cent, plus or minus, for any given coil. If a resistance above 5 ohms is specified which cannot be obtained with standard A.W.G. wire, using full-wound coils, the Manufacturer may furnish the nearest resistance to this value, using full-wound coils with standard A.W.G. wire.

13. *Binding posts.*

(a) Binding posts shall conform to Drawing 1070, assembly 107010, except as specified in section 10-g, where assembly 10705 or 107020 may be used.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied.

(c) Binding posts supporting the fixed parts of front and back contacts shall be fastened in their supports so as to preclude adjustment of any kind without first breaking the seal of the relay.

(d) Binding posts shall be spaced not less than 1 in. centers.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 1, 10-b to 10-k, inclusive, and 13, of Specification 154-39—
Tractive Armature Direct Current Neutral Relay For
Series Line Approach Lighting, Manual Part 101.

(Revision of A.A.R. Signal Section Specification 105-39)
A.A.R. SIGNAL SECTION SPECIFICATION 105-49.

TRACTIVE ARMATURE DIRECT CURRENT NEUTRAL RELAY WITH TWO OR MORE CONTACT FINGERS

Proposed Revision

1. Purpose.

(a) This specification is for the purpose of providing a tractive armature direct current neutral relay, first voltage range, suitable for vital circuits. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

Note.—The slower shunting characteristics of track relay of four or more contacts covered by this specification should be recognized.

10. Coils.

(b) Coils shall be wound with insulated wire and treated so as not to be injuriously affected by atmospheric conditions or by changes in temperatures between 40 deg. F. below zero and 185 deg. F. above zero.

1. Enameled wire shall be in accordance with Specification 193, Manual Part 183.

2. Cotton-covered wire shall be in accordance with Specification 194, Manual Part 189.

3. Silk-covered wire shall be in accordance with Specification 195, Manual Part 200.

(c) Coils external to the housing of moving parts shall be impregnated by vacuum and pressure with insulating compound in accordance with Requisites for Compound for Impregnation of Electrical Windings, Manual Part 171.

(d) When enamel insulation on No. 16 A.W.G. wire or smaller is used on impregnated coils, a cotton thread shall be placed between layers and built up at each end to a minimum thickness of $\frac{1}{16}$ in.

(e) Insulating material used for fillers in winding coils shall be chemically neutral.

(f) Coils shall be so insulated that they will withstand the insulation test provided in section 14. This test shall be made by mounting coil on a snugly fit metal mandrel and making breakdown tests between mandrel and winding; also by standing coil on each end in turn on a metal plate and testing between plate and winding.

(g) Connecting terminals of coils shall be joined either by a 14-24 or 10-32 binding post. Terminal leads of coils shall be of strands of tinned copper not larger than No. 28 A.W.G. wire.

10. *Coils.*—Continued.

The aggregate cross-section of the strands shall at least equal that of No. 18 A.W.G. wire. Leads shall be so insulated that they will withstand the insulation test provided in section 14.

(h) The coil terminal wires from the ends of the coil closest to the cores shall be used as lead wires.

(i) Coils shall be protected in a suitable manner from mechanical injury.

(j) At 68 deg. F. the percentage of variation in the resistance of individual coils shall not exceed:

1. For 5 ohms or less, plus or minus 5 per cent.
2. Above 5 ohms, plus or minus 10 per cent.

(k) Each coil shall be plainly and permanently marked, showing the Manufacturer's reference, nominal resistance, number of turns, size of wire and kind of wire insulation on a tag of non-conductive material adjacent to the outside lead.

(l) All coils shall be full-wound and the number of turns shall not be permitted to vary more than 5 per cent, plus or minus, for any given coil. If a resistance above 5 ohms is specified which cannot be obtained with standard A.W.G. wire, using full-wound coils, the Manufacturer may furnish the nearest resistance to this value, using full-wound coils with standard A.W.G. wire.

13. *Binding posts.*

(a) Binding posts shall conform to Drawing 1070, assembly 107010, except as specified in section 10-g, where assembly 10705 or 107020 may be used.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied.

(c) Binding posts supporting the fixed parts of front and back contacts shall be fastened in their supports so as to preclude adjustment of any kind without first breaking the seal of the relay.

(d) Binding posts shall be spaced not less than 1 in. centers.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Sections 1, 10-b to 10-k, inclusive, and 13, of Specification 105-39—
Tractive Armature Direct Current Neutral Relay With Two
or More Contact Fingers, Manual Part 123.

For low-voltage arresters, inspection and testing should be periodic with suitable test sets which should have visual inspection and such tests may be made that for many of these low-voltage units removed may be in less time.

Information obtained from manufacturers relative to higher voltage arresters, 3,000 volts or more, is as follows: The field testing of lightning arresters has always proven to be very difficult as these tests are usually rather inconclusive and even factory tests are not usually conclusive unless a surge generator is available. The usual low-frequency test on either 25 or 60 cycles will, of course, only give the approximate breakdown voltage for the arrester. Such tests should be made with a high value of current limiting resistance in the circuit and preferably a milliammeter should also be used. When arresters are tested in this manner, sufficient resistance should always be used to keep the discharge current below 30 milliamperes after breakdown and this current should be interrupted as soon as possible. The breakdown voltage is some indication of the condition of the arrester and the sharpness of breakdown is of equal or greater significance. In other words, there should be no leakage evident below breakdown voltage. Such breakdown tests would usually be considered impractical on an arrester in the field.

Tests on lightning arresters are not normally made in the field, except on complaints of radio interference. If the radio noise can be traced to an arrester by use of a portable set, the arrester in question is removed from service. It is then brought into the test department, where a voltage somewhat less than the 60-cycle breakdown value is applied and it is again checked for radio interference emission. Invariably, when such an arrester that causes noise is broken apart, corrosion is found on the gaps and other evidence of moisture infiltration is noticed.

No information is available as to any other readily applied tests on arresters without removing them from service, and experience indicates that the radio interference test at the arrester ground lead will pick out most of the units that are definitely defective.

Testing high-voltage arresters in the field with power factor testing equipment has been tried. This method seems to hold promise of a method of obtaining relative values of deterioration, since those units found to have a comparatively high power factor on test ultimately failed.

Action Recommended

Acceptance as information.

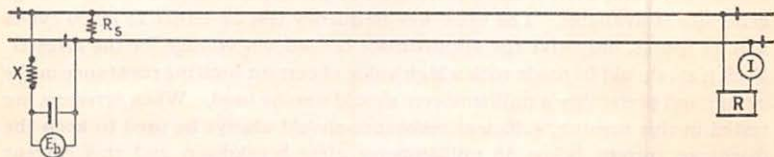
ating current, or less, inspection arresters may be tested in the field. Air gap and valve type arresters are tested by megger, and the method of testing is by megger. The information available indicates that the units may be replaced, and the point to much better advantage and

FORMULAE FOR COMPUTING RESISTANCE BETWEEN BATTERY AND TRACK AND FOR COMPUTING MINIMUM ALLOWABLE RESISTANCE BETWEEN BATTERY AND TRACK WITH A SELECTED VALUE OF TRACK SHUNT RESISTANCE.

MINIMUM ALLOWABLE RESISTANCE BETWEEN BATTERY AND TRACK WITH A SELECTED VALUE OF TRACK SHUNT RESISTANCE.

- I. Formula for computing minimum allowable resistance between track battery and track to insure relay with a selected value of track shunt resistance.

END-FED SECTION



I-A.
$$X = \frac{E_b - RI}{\frac{RI}{R_s} + I}$$

Where:

R = Resistance of relay.

I = Maximum permissible current through relay with track shunt R_s applied.

R_s = Resistance of track shunt.

E_b = Maximum voltage across battery terminals with track shunted at battery.

X = Minimum allowable resistance between track battery and track.

I-B. Assumptions:

Ballast resistance = Infinity.

Rail resistance = Zero.

Resistance of wiring between relay and track = Zero.

I-C. Example:

R = 4 ohms.

I = 0.027 ampere (silicon steel) (0.032 minus 0.005 ampere)

R_s = 0.06 ohm.

E_b = 0.90 volt.

$$X = \frac{0.90 - (4 \times 0.027)}{\frac{4 \times 0.027}{0.06} + 0.027} = \frac{0.792}{1.827} = 0.433 \text{ ohm.}$$

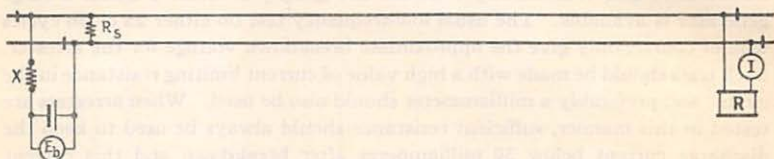
(Revision of Formulae for Computing Minimum Allowable Resistance between Track Battery and Track for Computing Related Current and Voltage Data)

FORMULAE FOR COMPUTING MINIMUM ALLOWABLE RESISTANCE BETWEEN TRACK BATTERY AND TRACK AND FOR COMPUTING RELATED CURRENT AND VOLTAGE DATA

1949

- I. Formula for computing minimum allowable resistance between track battery and track to insure shunting of track relay with a selected value of track shunt resistance.

END - FED SECTION



$$\text{I-A.} \quad X = \frac{E_b - RI}{\frac{RI}{R_s} + I}$$

Where:

R = Resistance of relay.

I = Maximum permissible current through relay with track shunt R_s applied. R_s = Resistance of track shunt. E_b = Maximum voltage across battery terminals with track shunted at battery.

X = Minimum allowable resistance between track battery and track.

I-B. Assumptions:

Ballast resistance = Infinity.

Rail resistance = Zero.

Resistance of wiring between relay and track = Zero.

I-C. Example:

R = 4 ohms.

I = 0.027 ampere (silicon steel) (0.032 minus 0.005 ampere)

 R_s = 0.06 ohm. E_b = 0.90 volt.

$$X = \frac{0.90 - (4 \times 0.027)}{\frac{4 \times 0.027}{0.06} + 0.027} = \frac{0.792}{1.827} = 0.433 \text{ ohm.}$$

IN-SERVICE TESTS OF ALL TYPES PRACTICABILITY OF LIGHTNING ARRESTERS OF LIGHTNING ARRESTERS

For low-voltage arresters, 75 volts alternating current, or less, inspection and testing should be periodic. Rare gas arresters may be tested in the field with suitable test sets which are available. Air gap and valve type arresters should have visual inspection. The preferred method of testing is by megger, and such tests may be made in the field. The information available indicates that for many of these low-voltage arresters, the units may be replaced, and the tests on units removed may be made at a central point to much better advantage and in less time.

Information obtained from manufacturers relative to higher voltage arresters, 3,000 volts or more, is as follows: The field testing of lightning arresters has always proven to be very difficult as these tests are usually rather inconclusive and even factory tests are not usually conclusive unless a surge generator is available. The usual low-frequency test on either 25 or 60 cycles will, of course, only give the approximate breakdown voltage for the arrester. Such tests should be made with a high value of current limiting resistance in the circuit and preferably a milliammeter should also be used. When arresters are tested in this manner, sufficient resistance should always be used to keep the discharge current below 30 milliamperes after breakdown and this current should be interrupted as soon as possible. The breakdown voltage is some indication of the condition of the arrester and the sharpness of breakdown is of equal or greater significance. In other words, there should be no leakage evident below breakdown voltage. Such breakdown tests would usually be considered impractical on an arrester in the field.

Tests on lightning arresters are not normally made in the field, except on complaints of radio interference. If the radio noise can be traced to an arrester by use of a portable set, the arrester in question is removed from service. It is then brought into the test department, where a voltage somewhat less than the 60-cycle breakdown value is applied and it is again checked for radio interference emission. Invariably, when such an arrester that causes noise is broken apart, corrosion is found on the gaps and other evidence of moisture infiltration is noticed.

No information is available as to any other readily applied tests on arresters without removing them from service, and experience indicates that the radio interference test at the arrester ground lead will pick out most of the units that are definitely defective.

Testing high-voltage arresters in the field with power factor testing equipment has been tried. This method seems to hold promise of a method of obtaining relative values of deterioration, since those units found to have a comparatively high power factor on test ultimately failed.

Action Recommended

Acceptance as information.

I-D. Maximum permissible current I through relay with track shunted. Current values shown are 0.005 ampere less than minimum field drop-away value:

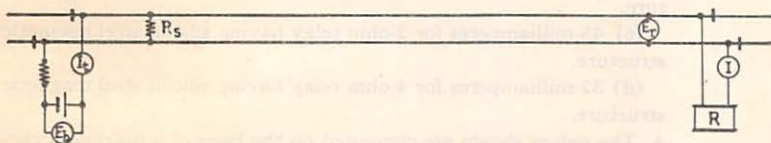
- (a) 30 milliamperes for 2-ohm, ordinary-acting, 2 or 4-contact relay having iron magnetic structure.
- (b) 20 milliamperes for 4-ohm, ordinary-acting, 2 or 4-contact relay having iron magnetic structure.
- (c) 40 milliamperes for 2-ohm, ordinary-acting, 2 or 4-contact relay having silicon steel magnetic structure.
- (d) 27 milliamperes for 4-ohm, ordinary-acting, 2 or 4-contact relay having silicon steel magnetic structure.

I-E. Maximum battery terminal voltage E_b :

This voltage is determined for any make, number, and arrangement of cells by measuring the terminal voltage when the battery is of maximum strength and discharging current equal to the value calculated in accordance with Item II and the temperature is such as to give maximum terminal voltage.

II. Formula for computing the current discharge from battery with the selected shunt resistance R_s .

This formula is used to calculate the current discharge values referred to in Item I-E. The maximum battery voltage E_b is taken during the time of this current discharge.



$$\text{II-A. } I_t = I + \frac{E_r}{R_s}$$

Where:

R = Resistance of relay.

I = Maximum permissible current through relay with track shunt R_s applied.

R_s = Resistance of track shunt.

$E_r = IR$ = Maximum allowable voltage on rails when track shunt R_s is applied.

I_t = Current flow from battery when track shunt resistance R_s is applied.

II-B. Assumptions:

Ballast resistance = Infinity.

Rail resistance = Zero.

Resistance of wiring between relay and track = Zero.

II-C. Example:

$$R = 4 \text{ ohms.}$$

$$I = 0.027 \text{ ampere (silicon steel) (0.032 minus 0.005 ampere)}$$

$$R_s = 0.06 \text{ ohm.}$$

$$E_r = IR = 0.027 \times 4 = 0.108 \text{ volt.}$$

$$I_t = 0.027 + \frac{0.108}{0.06} = 0.027 + 1.80 = 1.827 \text{ amperes.}$$

III. Tables of minimum allowable resistance in series with track battery for non-coded direct current track circuits—for track circuits having 2-ohm or 4-ohm relays.

Explanations:

1. Tables I, II, III and IV indicate the minimum resistance to be used with various battery voltages to insure that the track relay will be de-energized when the specified shunt resistance is applied.

2. The minimum allowable resistance includes resistance of wiring, resistance unit, relay and pole-changer contacts between track battery and track.

3. The drop-away value of track relays in service must not be less than the minimum field requirements given in Table I—Operating Characteristics of Tractive Armature Direct Current Relays, Manual Part 126, and in no case less than:

(a) 35 milliamperes for 2-ohm relay having iron magnetic structure.

(b) 25 milliamperes for 4-ohm relay having iron magnetic structure.

(c) 45 milliamperes for 2-ohm relay having silicon steel magnetic structure.

(d) 32 milliamperes for 4-ohm relay having silicon steel magnetic structure.

4. The values shown are computed on the basis of a maximum current through the relay equal to 5 milliamperes less than the minimum field requirement drop-away value when the specified shunt resistance is applied across the rails. This provides a factor of safety. Because the rail resistance and lead resistance between relay and track have been neglected in the calculations for these tables, an additional factor of safety is provided.

5. To determine the minimum allowable resistance required:

(a) Select a shunt resistance value of 0.06 ohm which is commonly used for average conditions, unless there are conditions involved which make it desirable to use a different value.

(b) Determine the maximum voltage of the track battery for the particular make, number and arrangement of cells while discharging current as explained in Item II; then from Table I, II, III or IV, in column under specified shunt resistance, the minimum allowable resistance between battery and track will be found opposite the value of battery voltage. If the battery voltage is between values shown in the first column, use the next higher voltage shown or interpolate between values.

6. The resistance value should be in all cases as much greater than the minimum allowable shown in Table I, II, III or IV as will permit reliable operation of the track circuit. This will result in much lower than the drop-away current value in the relay when the track is shunted with the selected value of shunt and will insure that the current through the relay is reduced to the drop-away value by a higher value of shunt resistance than that selected.

TABLE I

For Use with 2-Ohm, Ordinary-Acting Relay with 2 or 4-Contact Fingers, Having Iron Magnetic Structure

(Based on 0.030 ampere maximum to relay with track shunt applied)

Maximum battery voltage E_b , volts	Minimum allowable resistance in series with track battery, ohms		
	For $R_s=0.10^*$	For $R_s=0.08^*$	For $R_s=0.06^*$
0.60	0.86	0.69	0.52
0.65	0.94	0.76	0.57
0.70	1.02	0.82	0.62
0.75	1.10	0.89	0.67
0.80	1.18	0.95	0.72
0.85	1.26	1.01	0.77
0.90	1.33	1.08	0.82
1.00	1.49	1.21	0.91
1.10	1.65	1.34	1.01
1.20	1.81	1.46	1.11
1.30	1.97	1.59	1.20
1.40	2.13	1.72	1.30
1.50	2.29	1.85	1.40
1.60	2.45	1.97	1.50
1.70	2.61	2.10	1.59
1.80	2.76	2.23	1.69
1.90	2.92	2.36	1.79
2.00	3.08	2.49	1.88
2.10	3.24	2.62	1.98
2.20	3.40	2.75	2.08
2.30	3.56	2.88	2.17
2.40	3.72	3.00	2.27
2.50	3.88	3.13	2.37

* R_s = Track shunt resistance in ohms.

TABLE II

For Use with 2-Ohm, Ordinary-Acting Relay with 2 or 4-
Contact Fingers, Having Silicon Steel Magnetic Structure

(Based on 0.040 ampere maximum to relay with track
shunt applied)

Maximum battery voltage E_b , volts	Minimum allowable resistance in series with track battery, ohms		
	For $R_s = 0.10^*$	For $R_s = 0.08^*$	For $R_s = 0.06^*$
0.60	0.62	0.50	0.38
0.65	0.68	0.55	0.42
0.70	0.74	0.60	0.45
0.75	0.80	0.64	0.49
0.80	0.86	0.69	0.53
0.85	0.92	0.74	0.56
0.90	0.98	0.79	0.60
1.00	1.09	0.88	0.67
1.10	1.21	0.98	0.74
1.20	1.33	1.08	0.82
1.30	1.45	1.17	0.89
1.40	1.57	1.27	0.96
1.50	1.69	1.37	1.03
1.60	1.81	1.46	1.11
1.70	1.93	1.56	1.18
1.80	2.05	1.65	1.25
1.90	2.17	1.75	1.33
2.00	2.29	1.85	1.40
2.10	2.41	1.94	1.47
2.20	2.53	2.04	1.55
2.30	2.64	2.13	1.62
2.40	2.76	2.23	1.69
2.50	2.88	2.33	1.76

* R_s = Track shunt resistance in ohms.

TABLE III

For Use with 4-Ohm, Ordinary-Acting Relay with 2 or 4-
Contact Fingers, Having Iron Magnetic Structure

(Based on 0.020 ampere maximum to relay with track
shunt applied)

Maximum battery voltage E_b , volts	Minimum allowable resistance in series with track battery, ohms		
	For $R_s=0.10^*$	For $R_s=0.08^*$	For $R_s=0.06^*$
0.60	0.63	0.51	0.38
0.65	0.70	0.56	0.42
0.70	0.76	0.61	0.46
0.75	0.82	0.66	0.50
0.80	0.88	0.71	0.53
0.85	0.94	0.75	0.57
0.90	1.00	0.80	0.61
1.00	1.12	0.90	0.68
1.10	1.24	1.00	0.75
1.20	1.37	1.10	0.83
1.30	1.49	1.20	0.90
1.40	1.61	1.29	0.98
1.50	1.73	1.39	1.05
1.60	1.86	1.49	1.13
1.70	1.98	1.59	1.20
1.80	2.10	1.69	1.27
1.90	2.22	1.78	1.35
2.00	2.34	1.88	1.42
2.10	2.46	1.98	1.50
2.20	2.59	2.08	1.57
2.30	2.71	2.18	1.65
2.40	2.83	2.28	1.72
2.50	2.95	2.37	1.79

* R_s = Track shunt resistance in ohms.

TABLE IV

For Use with 4-Ohm, Ordinary-Acting Relay with 2 or 4-
Contact Fingers, Having Silicon Steel Magnetic Structure

(Based on 0.027 ampere maximum to relay with track
shunt applied)

Maximum battery voltage E_b , volts	Minimum allowable resistance in series with track battery, ohms		
	For $R_s=0.10^*$	For $R_s=0.08^*$	For $R_s=0.06^*$
0.60	0.45	0.36	0.27
0.65	0.49	0.39	0.30
0.70	0.54	0.43	0.32
0.75	0.58	0.47	0.35
0.80	0.63	0.50	0.38
0.85	0.67	0.54	0.41
0.90	0.72	0.57	0.43
1.00	0.81	0.65	0.49
1.10	0.90	0.72	0.54
1.20	0.99	0.79	0.60
1.30	1.08	0.87	0.65
1.40	1.17	0.94	0.71
1.50	1.26	1.01	0.76
1.60	1.35	1.08	0.82
1.70	1.44	1.16	0.87
1.80	1.53	1.23	0.93
1.90	1.62	1.30	0.98
2.00	1.71	1.37	1.03
2.10	1.80	1.45	1.09
2.20	1.89	1.52	1.14
2.30	1.98	1.59	1.20
2.40	2.07	1.66	1.25
2.50	2.16	1.73	1.31

* R_s = Track shunt resistance in ohms.

- IV. Modification to provide for including rail resistance and relay lead resistance, when desired:

The assumptions in Item I-B simplify the calculations, but give values of X that will provide higher actual shunting sensitivity than the assumed value of R_s , because of the resistance of rails and relay leads. This discrepancy is, of course, in the direction of providing increased margin of safety. With a 2 or 4-ohm track relay, neglecting the resistance of the rails and relay leads does not make much differ-

ence in most track circuits, but when the track relay has a low-resistance winding, such as 0.5 ohm, it is desirable to include the effect of these resistances in the calculation as follows:

IV-A. Method for including effect of resistance of rails and relay leads in the calculation for minimum allowable resistance between track battery and track:

The value of relay lead resistance used should be the minimum that is known to exist. A typical value would be 0.10 ohm. The value of R , the relay resistance in the formula, is then increased by this amount. Similarly, the value of rail resistance used should be the minimum value for the type of rail and bonding as measured in tests or from known values of rail resistance and joint resistance. A typical value would be 0.025 ohm per 1,000 feet of track (2,000 feet of rail).

When rail resistance is used, in general, a calculation should be made for the shunt applied at the battery end of the track and a second calculation made for the shunt applied at the relay end. The larger value of X from these two calculations should be used. Usually the shunt at the battery end requires the larger value of X , but for some track circuits with high battery voltage, the shunt applied at the relay end may be the more adverse condition and require the larger value of X .

IV-B. Shunt at battery end:

The value of rail resistance is added to the resistance of relay and relay leads, and the resulting value R^1 is used in place of R in Item I.

IV-C. Shunt at relay end:

A preliminary value X^1 is calculated from Item I and the value of rail resistance is subtracted from this value X^1 to find the actual value of X .

IV-D. The maximum battery terminal voltage E_b is determined as explained in Item I-E, with the battery discharging current as calculated in accordance with Item II. It is not necessary to include the rail and relay lead resistance in this calculation. Neglecting these resistances results in a lower calculated discharge current, which in turn gives a higher battery voltage. This is in the direction of greater safety.

IV-E. Example:

(Same conditions as Item I-C).

$$R = 4 \text{ ohms.}$$

$$I = 0.027 \text{ ampere,}$$

$$R_s = 0.06 \text{ ohm.}$$

$$E_b = 0.90 \text{ volt,}$$

Track circuit length = 4,000 feet; total rail resistance = $4 \times 0.025 = 0.10$ ohm.

Relay lead resistance = 0.10 ohm.

Shunt at battery end:

$$X = \frac{E_b - R'I}{\frac{R'I}{R_g} + I} = \frac{0.90 - (4.2 \times 0.027)}{\frac{(4.2 \times 0.027)}{0.06} + 0.027} = \frac{0.90 - 0.1134}{\frac{0.1134}{0.06} + 0.027} = \frac{0.7866}{1.89 + 0.027} = \frac{0.7866}{1.917} = 0.41 \text{ ohm.}$$

Shunt at relay end:

Values same as above.

$$X' = \frac{0.90 - (4.1 \times 0.027)}{\frac{(4.1 \times 0.027)}{0.06} + 0.027} = \frac{0.90 - 0.1107}{1.845 + 0.027} = \frac{0.7893}{1.872} = 0.422 \text{ ohm.}$$

$$X = 0.422 - 0.10 = 0.322 \text{ ohm.}$$

Use 0.41 ohm for minimum allowable resistance.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Formulae for Computing Minimum Allowable Resistance Between Track Battery and Track and for Computing Related Current and Voltage Data, Manual Part 132.

COOPERATIVE REPORT

AMERICAN PETROLEUM INSTITUTE
CORRELATING COMMITTEE ON CATHODIC PROTECTIONR. B. Amsden, Representative
G. P. Neal, Alternate

Progress reports on the activities of the Correlating Committee on Cathodic Protection, a continuing organization composed of representatives of eleven industry associations and communication companies and sponsored by the American Petroleum Institute, were presented in A.A.R. Signal Section 1946 and 1947 Proceedings, Vols. XLIV and XLV, pages 164-A and 154, respectively.

Bulletin I, reproduced in part in Vol. XLV, p. 155, informs management about the economic value of cathodic protection as a technique for combating corrosion of underground and buried water, gas and oil pipes, communication, signal and power cables, rail track systems, tanks, equipment foundations and other metallic structures in contact with the soil or water. This bulletin also describes the stray current problem arising from cathodic protection and the need for cooperative study and tests by the engineers of the operators of neighboring buried structures which may be involved. Stray cathodic protection currents may affect the operation of railroad signal systems.*

At a meeting held at the Netherland Plaza Hotel in Cincinnati, Ohio, on April 8 and 9, 1949, the Committee completed two more bulletins of the series to be issued, Bulletin II—Cathodic Protection Notification Procedures, and Bulletin IV—Joint Cathodic Protection Systems.

Bulletin II explains the obligation of an operator, intending to cathodically protect his structure, to notify his neighboring structure owners of his intention at the time such protection is contemplated. It shows the mutual advantages when each neighboring owner in turn responds to such notification and cooperates in the proper engineering of the problem before the work of installation is commenced. The bulletin lists some sources of information to assist in determining the location of certain types of buried structures, the names of their operators and in some cases data on business addresses and personnel so that appropriate notices can be sent. Because of the varied nature of installation no standard form of notification is recommended but the bulletin lists the pertinent information to be included in each notification regarding a new installation. A railroad interested in determining the locations of existing cathodic protection along its right-of-way should send inquiries to the owners of neighboring buried structures and arrange for joint tests to determine whether or not a potential condition exists which might cause interference with operation of the signal system under certain abnormal conditions.

Bulletin IV discusses the techniques of design and installation of joint cathodic protection systems and possible divisions of responsibility for their

* See A.A.R. Signal Section 1942 Proceedings, Vol. XL, p. 153-A.

operation and maintenance and the sharing of costs. Also it outlines the principal points that may be included in any agreement between the structure owners covering these features. Where neighboring structures of two or more operators are subject to similar natural corrosion damage, joint cathodic protection systems can be designed, installed and operated economically to the benefit and satisfaction of all concerned.

Bulletin III, when completed, will contain information concerning the technical aspects of cathodic protection coordination.

Action Recommended

Acceptance as information.

COMMITTEE V—CONTRACTS AND INSTRUCTIONS

Personnel

C. D. Cronk, Chairman

G. A. Washburn, Vice-Chairman

G. T. Callahan	E. B. Platt
B. F. Dickinson	E. L. Rogers
R. C. Dueland	G. C. Schindler
A. C. Eastman	W. L. Scott
O. Falkenstein	S. P. Searle
A. Hunot	A. L. Shepard
F. M. Kunker	W. H. Stilwell
G. R. Pflasterer	E. S. Taylor
F. Youngwerth	

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Instructions for testing signal installations before placing in service.
4. Definitions for technical terms used in signaling.
5. Forms for reporting progress of the component parts of new signal installations and expenditures for labor.
6. Investigate and report on a simplified system of numbering and identification of wires and circuits which does not require the changing of nomenclature and tags on wayside circuits when a minor change is made.
7. Investigate and report on the use of portable induction type telephones by signal forces.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Definitions for Technical Terms used in Signaling, Manual Part 55.
 - Revision of Instructions for Direct Current Relays, Manual Part 126.
 - Revision of Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.
 - Revision of Instructions for Wire and Cable, Manual Part 190.
 - Revision of Instructions for Car Retarder Systems, Manual Part 125.
 - Revision of Instructions for Interlocking, Manual Part 138.
 - Revision of Circuit Nomenclature and Written Circuits, Manual Part 33.
 - Revision of A.A.R. Sig. Sec. 1664B, 1673C and 1674D.
- Cooperative report. Purchases and Stores Division, A.A.R.—General Reclamation Committee.
- Cooperative report. American Standards Association—Graphical Symbols and Abbreviations—Project Z32.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

Disposition of 1948 Letter Ballot Subjects

The following subjects presented by this Committee at the 1948 Annual Meeting were submitted to letter ballot and officially approved:

Definitions for Technical Terms Used in Signaling—Now in Manual Part 55.

Instructions for Non-Coded Alternating Current Track Circuits—Now in Manual Part 162.

Instructions for Electronic Tubes—Now in Manual Part 250.

Instructions for Storage Batteries—Now in Manual Part 14.

Instructions for Electric Locks for Interlocking Machines—Now in Manual Part 23.

Instructions for Automatic Block Signal Systems—Now in Manual Part 102.

Instructions for Switch Circuit Controllers—Now in Manual Part 134.

Instructions for Automatic Highway Grade Crossing Protective Systems—Now in Manual Part 150.

Instructions for Facing Point Locks Applied to Spring Switches—Now in Manual Part 159.

A.A.R. Sig. Sec. 1673C (Three Sheets)—Graphical Symbols—Relays—Now in Drawing Section of Manual.

A.A.R. Sig. Sec. 1674D (Three Sheets)—Graphical Symbols—Relay Contacts—Now in Drawing Section of Manual.

(Revision of Definitions for Technical Terms Used in Signaling)
A.A.R. SIGNAL SECTION DEFINITIONS.

TECHNICAL TERMS USED IN SIGNALING

1949

Adjustment, Bracket Switch. (New)

See definition for Bracket, Switch Adjustment.

Bracket, Switch Adjustment. (Superseding Adjustment, Switch)

A device attached to the No. 1 rod to which the operating rod is connected and which permits the adjustment of a switch, derail or movable point frog.

Rod, No. 1. (New)

See definition for Rod, Head.

Switch Adjustment Bracket. (Superseding Switch Adjustment)

See definition for Bracket, Switch Adjustment.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of Instructions for Direct Current Relays)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

DIRECT CURRENT RELAYS

The Committee submits revision of Table I—Operating Characteristics of Tractive Armature Direct Current Relays appearing on page 6 of Instructions for Direct Current Relays, Manual Part 126.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Table I—Operating Characteristics of Tractive Armature Direct Current Relay, of Instructions for Direct Current Relays, Manual Part 126.

TABLE I—OPERATING CHARACTERISTICS OF TRACTIVE ARMATURE DIRECT CURRENT RELAYS

	Shop Requirements		Field Requirements	
	NEUTRAL RELAYS	POLARIZED RELAYS	NEUTRAL RELAYS	POLARIZED RELAYS
Initial charge	Four times pick-up	Four times pick-up	Service working current or voltage	Reverse working current or voltage
Drop-away value (See Note 1)	Not less than 90% of original marking nor less than 43% of pick-up	Not less than 90% of original marking nor less than 43% of pick-up	TRACK RELAYS—Not less than 67% of original marking and in no case less than: (a) 35 milliamperes for 2-ohm relay (b) 25 milliamperes for 4-ohm relay LINE RELAYS—Not less than 67% of original marking	TRACK RELAYS—Not less than 67% of original marking and in no case less than: (a) 35 milliamperes for 2-ohm relay (b) 25 milliamperes for 4-ohm relay LINE RELAYS—Not less than 67% of original marking
Drop-away value (See Note 2)	Not less than 95% of original marking	Not less than 95% of original marking	TRACK RELAYS—Not less than 85% of original marking and in no case less than: (a) 45 milliamperes for 2-ohm relay (b) 32 milliamperes for 4-ohm relay LINE RELAYS—Not less than 67% of original marking	TRACK RELAYS—Not less than 85% of original marking and in no case less than: (a) 45 milliamperes for 2-ohm relay (b) 32 milliamperes for 4-ohm relay LINE RELAYS—Not less than 67% of original marking
Normal pick-up value	Not more than 110% of original marking	Not more than 110% of original marking	Not more than 110% of original marking	Not more than 110% of original marking
Normal working value	Not more than 110% of original marking	Not more than 110% of original marking	Not more than 110% of original marking	Not more than 110% of original marking
Reverse working value		Not more than 110% of original marking		Not more than 110% of original marking
Normal and reverse polar pick-up and working value		Not more than 70% of pick-up of neutral armature		Not more than 80% of pick-up of neutral armature

Note 1: These values are for relays having iron magnetic structure.

Note 2: These values are for relays having silicon steel magnetic structure.

(Revision of Instructions for Time Releases Applied to Signal Apparatus)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

TIME RELEASES APPLIED TO SIGNAL APPARATUS

1949

1. The minimum release time setting of time releases should be more than the maximum time required for a train of minimum braking power to stop with a full service application of the brakes, before reaching a point where a stop is required.
2. The release time setting shall be the time required for a train to travel the distance between the approach signal and the point where a stop is required, at a speed not to exceed 30 miles per hour, plus a distance factor to provide additional time.
3. In territory where electric locks are applied to hand-operated switches, the release time setting shall be the time required for a train to travel the distance between the approach signal and the electric lock location, at a speed not to exceed 30 miles per hour, plus a distance factor to provide additional time.
4. The minimum release time setting shall be not less than the following:
 - (a) Where provided for signals controlling movements at medium or greater speed.....3 minutes.
 - (b) Where provided for signals controlling movements at less than medium speed.....10 seconds.
5. The release time setting must be indicated on plans and on each release.
6. The release time setting must be maintained in accordance with plans currently in effect.
7. Timing of electrically operated time releases must be made at service voltage.
8. Timing tests must be made periodically, as instructed.
9. Method for computing the release time setting where:

T = Time.

A = Distance between approach signal and point where stop is required and braking distance at maximum authorized speed is provided.

A¹ = Actual distance between first approach signal and the home signal.A² = Actual distance between the first and second approach signal.

B = Distance factor in feet approaching approach signal to provide additional time. (1,500 feet is considered a minimum for speed of 30 miles per hour.)

C = Feet per second at train speed not to exceed 30 miles per hour (1.467 × m.p.h.).

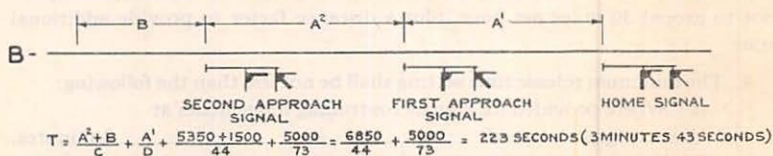
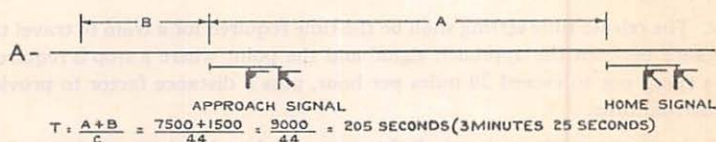
C¹ = Feet per second at train speed not to exceed 15 miles per hour (1.467 × m.p.h.).

D = Feet per second travelled at maximum speed for which first approach signal provides braking distance.

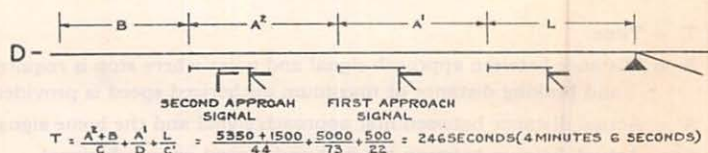
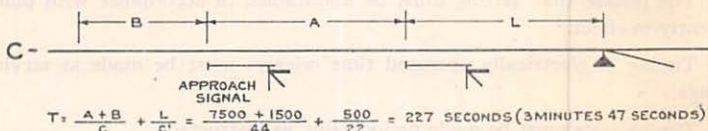
L = Actual distance between the electric lock and its protecting signal.

Note.—Where train speeds are less than 30 miles per hour or where physical conditions prevent trains from averaging 30 miles per hour in distance A plus B the time setting should be based on the distance travelled in feet at the average train speed attained.

10. Assumptions and examples:



NOTE: WHERE MORE THAN TWO APPROACH SIGNALS ARE REQUIRED, THE FORMULA FOR COMPUTING THE RELEASE TIME SETTING SHOULD BE EXPANDED AS REQUIRED.



Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.

(Revision of Instructions for Wire and Cable)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

WIRE AND CABLE

1949

Handling.

1. Care must be exercised in the shipping, handling, laying or pulling in, splicing and housing of wire and cable.
2. Wire or cable on reels should be shipped with all lagging properly in place. Care must be taken in nailing lagging to the reels so as not to puncture the insulation. Nails must not be used in securing tags to reels.
3. Wire or cable in coils should be shipped properly bound and wrapped with a protective covering of burlap or other suitable wrapping material. Tags giving a description of contents should be firmly attached to the coils, both inside and outside the wrapping.
4. Wire or cable not meeting the specification for the class of service intended must not be installed.
5. Wire or cable showing any evidence of injury must not be used without proper authority.
6. Wire or cable should be stored under cover where it will not become mildewed or liable to be damaged by other materials and must be kept away from excessive heat. Coils of braided wire or cable must be stored on edge.
7. Wire or cable must not be removed from reels or coils until ready to install. All nails must be removed from the edges of reels.
8. Reels must be set up so they will revolve easily and the wire or cable will pay off from the top. When wire is used from a coil, a "payout reel" should be used. The reel should be attended to prevent excessive slack from running out. If necessary to pay out by hand, the reversing of the coil every four or five turns will tend to prevent twisting.
9. Precaution must be taken to prevent the kinking or twisting of wire. Should any kink or twist unavoidably occur, do not attempt to pull or "throw out" the kink or twist but carefully remove it by hand.
10. Insulation must not be injured or bruised by dropping, stepping, throwing tools or material on wire.
11. Insulation must be kept free from oils, grease, acids and alkalis.
12. Wire or cable must not be pulled over rough surfaces or through hot cinders.
13. Separate wires or cables that are to go into one duct should be pulled in at one time. For small gage single-conductor wires, it is preferable to hitch to the copper conductors and so arrange the hitch that the pulling strain will equalize on all the wires involved in such a pull. The "basket-weave" hitch, which grips the outside of a cable, should be used when pulling in a multiple-conductor cable.

Handling.—Continued.

14. Braided cables or a number of single-conductor wires should be pulled in by hand in order to avoid straining conductors in the event they become "caught" in the conduit.

15. The following minimum bending radii for cable should be used:

- (a) Without metallic covering.....3 cable diameters.
- (b) With metallic covering.....5 cable diameters.

16. Ends of cable with metallic covering must be sealed.

17. When insulated wires or cables are used aurally they must be properly supported by and fastened to a messenger or insulator. They should enter housings and poles through bushings or specially formed entrances.

Conduits.

18. Conduit must be free of any foreign substances before starting to lay in wire or cable.

19. Wire and cable must be laid in conduit loosely without stretching or crowding and should not be doubled back in conduit. Slack should be taken care of in junction boxes or other housings.

20. Insulation should not come in contact with creosoted lumber.

21. Conduit must be so maintained as to prevent the entrance of rodents. Nails must not be driven through trunking from the inside of the groove, nor driven into the groove from the outside. Conduit must not be located where heat is excessive or other conditions tend to destroy insulation.

22. Before installing wire or cable in a duct, a mandrel of proper cross-section should be drawn through the duct to insure clearance and free interior of duct from obstruction.

Wire and cable entrances.

23. Wire and cable entrances must be properly sealed to prevent entrance of moisture, rodents and insects.

Wire joints.

24. Wire joints in single-conductor wires should be made in accordance with Specification, dated

25. Splices should not be made in any conductor underground.

26. Wire for use under tension must not be heated or soldered.

Cable splicing.

27. Splices must be made as instructed.

Terminal eyes.

28. In forming eyes or applying terminals to ends of wires, the wire must not be nicked or twisted.

Marking.

29. Wire must be properly identified with tags made of insulating material and so arranged that they will not interfere with any moving parts.

Line wire.

30. Line wire must be properly secured to insulator and tied in so as not to injure the wire or the insulation.

31. In removing insulation from wire, do not cut with knife at a right angle from the wire because a very slight nick may cause the wire to break at that point when subjected to strains and vibrations.

32. Line wires must be kept free from contact with guy wires, trees or structures.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions for Wire and Cable, Manual Part 190.

(Revision of Instructions for Car Retarder Systems)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

CAR RETARDER SYSTEMS

1949

Proposed Revision

General.

25. Retarders, switch and skate operating mechanisms must be kept in good condition and free from excessive lost motion. Manufacturer's instructions as to adjustments and maintenance must be followed unless they conflict with other general or detailed instructions, in which case proper authority must be consulted. All bearing parts must be kept properly lubricated. Lubricants used should be suitable to the weather encountered and should be in accordance with the recommendation of the manufacturer. Contacts must be kept clean and properly adjusted.

26. All movable parts must be kept free of foreign material which may interfere with proper operation.

27. Grease and dirt should be cleaned off the top of retarder beams and shoes and from beneath the shoes and the rails, and from underneath the operating parts.

28. Height of retarder shoes above the rail and distance between retarder shoes with retarder in open position must be maintained as instructed.

29. Retarder shoes must be replaced when worn out and care must be used when installing new or partially worn shoes to insure that one does not project beyond an adjacent shoe far enough for a wheel to hit and be lifted. Broken shoes which leave such a projection must be changed immediately.

30. When retarder shoes or beams are removed from one section of a retarder while the remainder of the machine is kept in service, tapered end shoes must be used or equivalent protection provided, as instructed, at both ends of the operable section so that a car wheel will enter the shoes without lifting.

(Instructions 29 to 37, inclusive, renumbered 31 to 39, inclusive.)

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions 25, 26, 27 and 28 of Instructions for Car Retarder Systems, Manual Part 125.

(Revision of Instructions for Interlocking)
A.A.R. SIGNAL SECTION INSTRUCTIONS.

INTERLOCKING*

1949

General.

1. Maintenance and repair work which may interfere with safe operation of trains or engines must not be started until such operation has been fully protected.

2. Before removing rails, switch points or frogs, protecting signals must be arranged to display their most restrictive indication. Signals must not be restored to normal operation until it is known that track is safe and inspection and tests have been made to determine that the signals function as intended.

3. When mechanical locking of interlocking machine is to be changed or removed from machine, or locking becomes disarranged or broken, proper measures must be taken to protect train or engine movements until interlocking is restored to normal operation.

4. Circuits must not be opened or shunted, contacts of controlling devices bridged, or any other action taken which may affect safety of train operation.

5. Machine must be kept in good condition, free from dust, grease, dirt and excessive lost motion. Levers and locking must be kept clean, all bearing parts properly lubricated, dowel pins tight, and sufficient tension in latch springs. Contacts must be kept clean and in proper adjustment.

6. During snow and sleet storms, switches and pipe lines must be kept clean. Where snow melting open flame methods are used, care must be exercised to prevent damage to apparatus.

7. Seals and padlocks, where provided, must be maintained and handled in accordance with instructions issued by proper authority.

8. Clearances must be maintained as required.

9. Paint must be applied as often as required to prevent deterioration. Rusty surfaces must be cleaned before painting. Paint must not be applied to threads or screw jaws, adjustable screws, cotters or gaskets.

10. Threads of rods, jaws and bolts, and bearings of all movable parts must be kept clean and properly lubricated.

11. Bolts must be kept tight. Cotter pins of the proper size must be in place in holes provided for that purpose, must be in good condition and properly spread.

12. Gaskets for housings must be in place, in good condition, of proper size, resistant to water, and provide a weatherproof and dustproof seal.

13. When movable parts are worn to such an extent as to create excessive lost motion, they must be replaced.

14. Batteries must be maintained and tested in accordance with Instructions for Batteries and Cells, Manual Part 7 or 14.

* These instructions will also apply to Centralized Traffic Control Systems.

General.—Continued.

15. Electric lamps must be maintained and tested in accordance with Instructions for Incandescent Electric Lamps, Manual Part 120.

16. Insulated rail joints must be maintained and tested in accordance with Instructions for Insulated Rail Joints, Manual Part 133.

17. Rectifiers and motor-generators must be maintained and tested in accordance with Instructions for Rectifiers and Motor-Generators, Manual Part 68.

18. Relays must be maintained and tested in accordance with Instructions for Relays, Manual Part 124 or 126.

19. Setting of time releases must be in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.

20. Electric locks must be maintained in accordance with Instructions for Electric Locks for Interlocking Machines, Manual Part 23.

21. Signals must be maintained and tested in accordance with Instructions for Light and Motor Semaphore Signals, Manual Part 54.

22. Switch circuit controllers must be maintained and tested in accordance with Instructions for Switch Circuit Controllers, Manual Part 134.

23. Track circuits must be maintained and tested in accordance with Instructions for Track Circuits, Manual Part 8, 162 or 218.

24. Wire and cable must be maintained and handled in accordance with Instructions for Wire and Cable, Manual Part 190.

25. Switches, movable point frogs and split point derails must be so maintained that they cannot be locked when $\frac{1}{4}$ inch obstruction is placed between stock rail and switch point 6 inches from point of switch.

26. Holes or notches in lock rods must have square edges and must not be more than $\frac{3}{16}$ inch larger than the locking bar or plunger.

27. Edges of locking dogs and rods of switch-and-lock movement or facing point lock must be maintained with not more than $\frac{1}{16}$ inch wear.

28. Point detector circuit controller must be so maintained that the contacts will not assume the positions indicating point closure if the switch point is closed with a $\frac{1}{4}$ inch obstruction placed between the stock rail and switch point 6 inches from point of switch.

29. Wires must be so arranged as not to interfere with operating parts of apparatus.

30. Circuits must be kept free of grounds which may interfere with proper operation.

31. Lightning arresters must be properly connected and maintained.

Tests.

32. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

33. When repair, adjustment, change or replacement is made in any part which may affect the operation of the interlocking, tests must be made immediately to determine that proper operation is assured.

Tests.—Continued.

34. Insulation resistance tests must be made in accordance with Instructions for Insulation Resistance, Manual Part 130.

35. Tests must be made periodically, as instructed, to determine that the various safety features are effective.

(Instructions 36 to and including 74—No change.)

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Instructions 1 to and including 35 of Instructions for Interlocking, Manual Part 138.

(Revision of Circuit Nomenclature and Written Circuits)

CIRCUIT NOMENCLATURE AND WRITTEN CIRCUITS

1949

Proposed Revision

*Table of Meaning of Letters
Descriptive and Designative Terms*

- B—Block—Button—Positive energy—Bridge—Back
 C—Common—Changer—Counter—Correspondence—Circuit—Controller—
 Code—Checking contacts—Change
 D—Proceed indication of a signal—Detector—Decoding—Dragging
 E—East—Eastward—Electric light—Element—Equipment—Electronic
 F—Traffic—Front—Frequency
 G—Green—Signal (operating mechanism)—Ground—Gate
 L—Left—Lock preventing initial movement of a lever from normal or reverse
 position—Locking—Lever—Light—Split battery—Lock valve—Lock
 M—Lock preventing final or indicating movement of a lever—Magnetic—
 Marker—Manual
 O—Order—Operating—Off—Overload—Out—Over
 R—Right—Red—Reverse—Relay—Power-operated controller or contactor—
 Route—Stop indication of a signal—Rail

Miscellaneous Operated Units

The following to be added to units now shown:

RLNPR—Rail lock normal repeating relay
RLRPR—Rail lock reverse repeating relay
DEDR —Dragging equipment detector
FCOR —Frequency change over relay

Wires Relating to Miscellaneous Operated Units

The following to be added to units now shown:

RLNP —Positive control of RLNPR
RLRP —Positive control of RLRPR
DED —Positive control of DEDR
FCO —Positive control of FCOR

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIG. SEC. 1664C.

GRAPHICAL SYMBOLS—WAYSIDE FIXTURES

A.A.R. SIG. SEC. 1673D (Three Sheets).

GRAPHICAL SYMBOLS—RELAYS

A.A.R. SIG. SEC. 1674E (Three Sheets).

GRAPHICAL SYMBOLS—RELAY CONTACTS

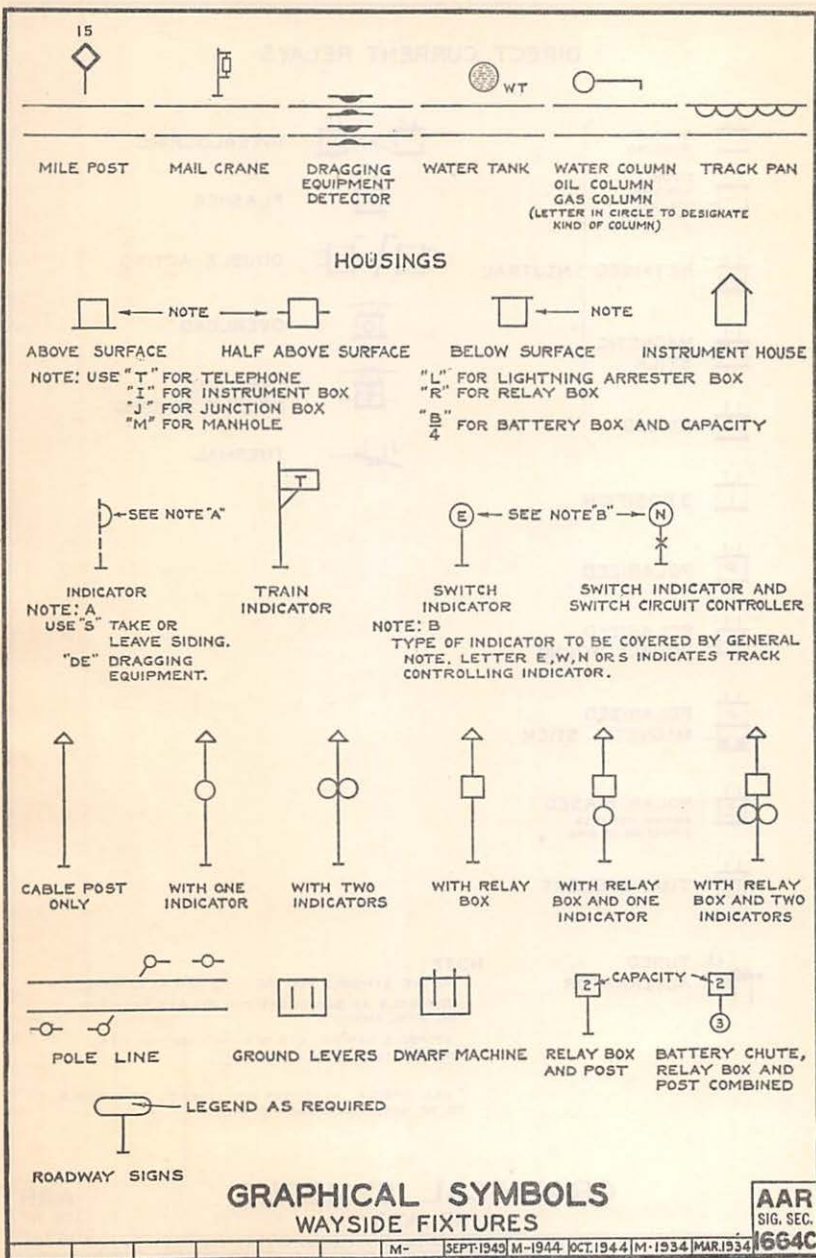
The Committee submits revision of A.A.R. Sig. Sec. 1664B, 1673C and 1674D.

Action Recommended

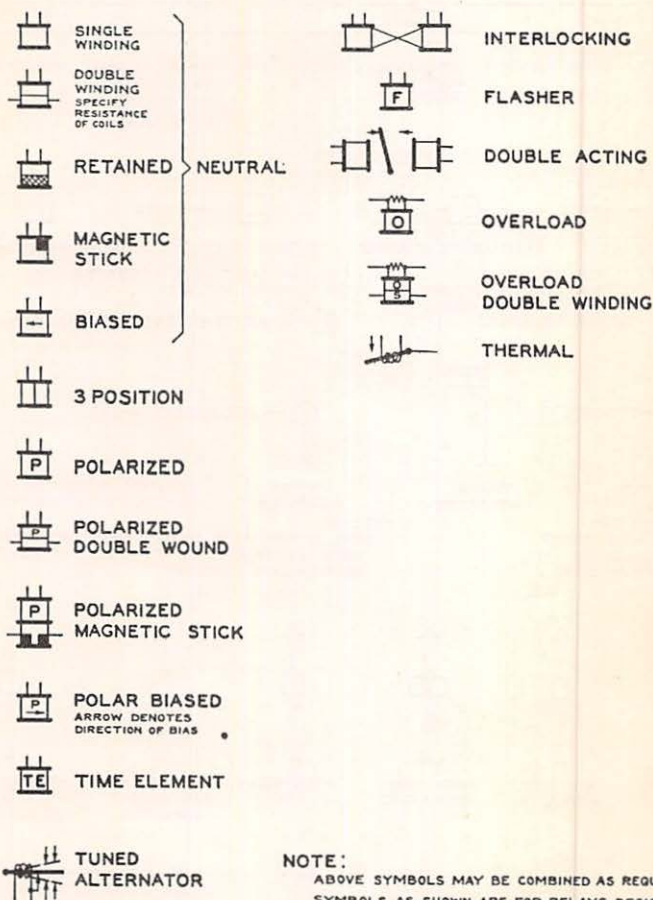
Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

A.A.R. Sig. Sec. 1664B—Graphical Symbols—Wayside Fixtures.
A.A.R. Sig. Sec. 1673C—Graphical Symbols—Relays (Three Sheets).
A.A.R. Sig. Sec. 1674D—Graphical Symbols—Relay Contacts (Three Sheets).



DIRECT CURRENT RELAYS



NOTE:

ABOVE SYMBOLS MAY BE COMBINED AS REQUIRED.
SYMBOLS AS SHOWN ARE FOR RELAYS DESIGNED
FOR VITAL CIRCUITS.

SYMBOLS FOR RELAYS DESIGNED FOR NON-VITAL
CIRCUITS TO BE SHOWN THUS **[NV]**

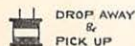
ALL SPECIAL FEATURES NOT COVERED BY SYMBOLS
TO BE NOTED ON CIRCUIT PLANS.

GRAPHICAL SYMBOLS
RELAYSAAR
SIG. SEC.

1673D

M- SEPT-1949 M-1948 SEPT-1948 M-1943 OCT-1943 M-1934 MAR-1934

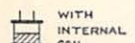
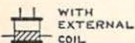
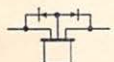
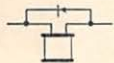
DIRECT CURRENT RELAYS

DROP
AWAYPICK
UPDROP AWAY
&
PICK UP

SLOW

DROP
AWAYPICK
UPDROP AWAY
&
PICK UP

QUICK

WITH
INTERNAL
COILWITH
EXTERNAL
COILRETAINED
NEUTRAL
POLARIZEDSLOW
PICK UPFULL WAVE
RECTIFIERHALF WAVE
RECTIFIER

RESISTOR

RELAYS WITH
RECTIFIER OR
RESISTORPOLAR
STICKOSCILLATING OR
PENDULUM TYPE
SINGLE WINDINGOSCILLATING OR
PENDULUM TYPE
DOUBLE WINDINGOSCILLATING OR
PENDULUM TYPE
LOCAL AND
STEPPING WINDINGCODE
TRANSMITTER2-POSITION
NON-STICK

3-POSITION

CODE
FOLLOWING2-POSITION
MAGNETIC STICK

NOTE:

ABOVE SYMBOLS MAY BE COMBINED AS REQUIRED.
SYMBOLS AS SHOWN ARE FOR RELAYS DESIGNED
FOR VITAL CIRCUITS.

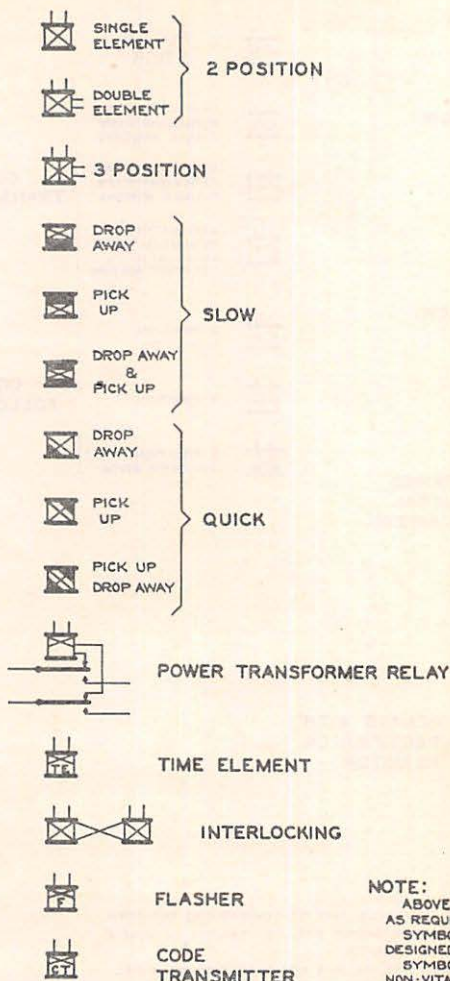
SYMBOLS FOR RELAYS DESIGNED FOR NON-VITAL
CIRCUITS TO BE SHOWN THUS **NV**

ALL SPECIAL FEATURES NOT COVERED BY SYMBOLS
TO BE NOTED ON CIRCUIT PLANS.

GRAPHICAL SYMBOLS
RELAYSAAR
SIG. SEC.
1673D

M- SEPT-1943 M-1948 SEPT-1948 M-1943 OCT-1943 M-1934 MAR-1934

ALTERNATING CURRENT RELAYS



NOTE:

ABOVE SYMBOLS MAY BE COMBINED AS REQUIRED.

SYMBOLS AS SHOWN ARE FOR RELAYS DESIGNED FOR VITAL CIRCUITS.

SYMBOLS FOR RELAYS DESIGNED FOR NON-VITAL CIRCUITS TO BE SHOWN THUS **NY**

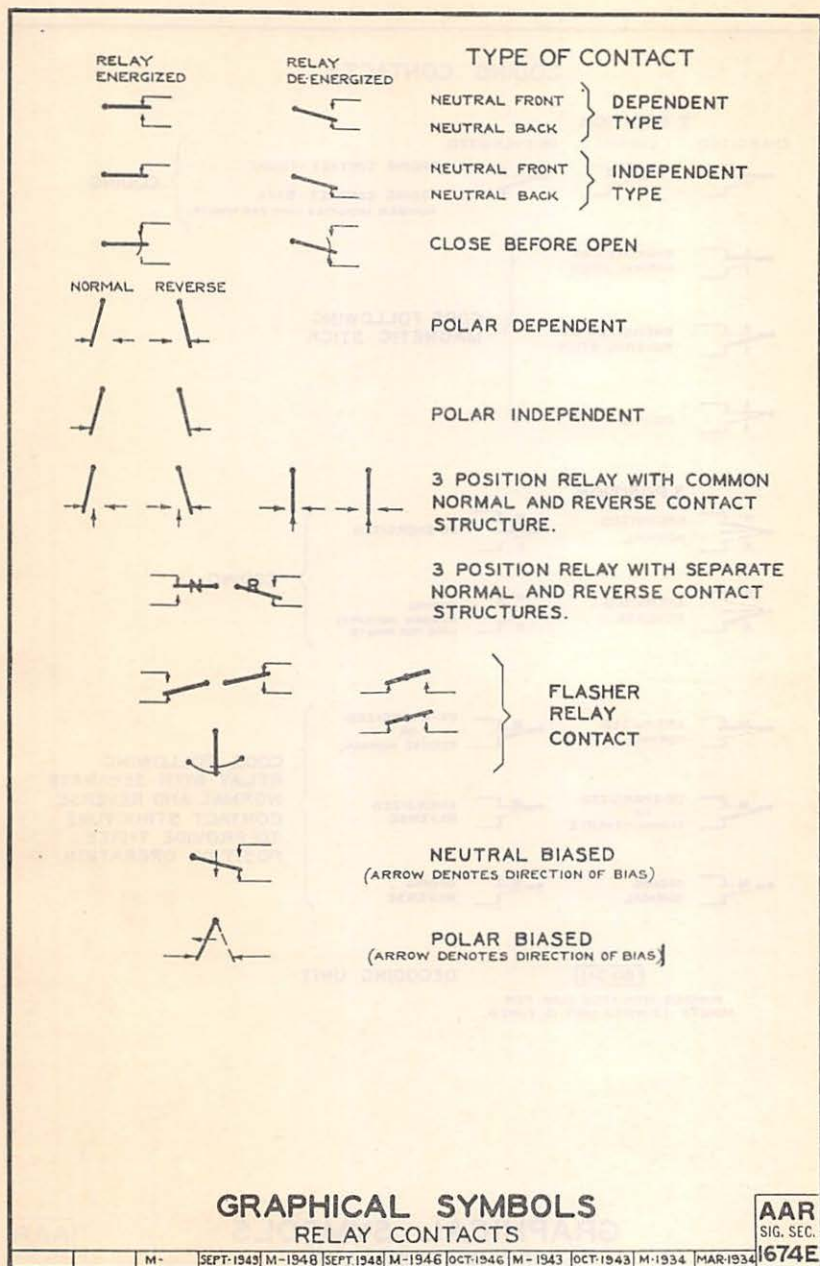
ALL SPECIAL FEATURES NOT COVERED BY SYMBOLS TO BE NOTED ON CIRCUIT PLANS.

GRAPHICAL SYMBOLS
RELAYS

AAR
SIG. SEC.
1673D

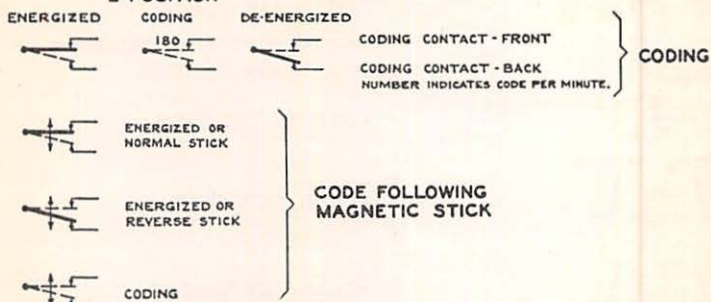
M- SEPT-1945 M-1948 SEPT-1948 M-1943 OCT-1943 M-1934 MAR-1934

(Sheet 3 of 3 sheets)

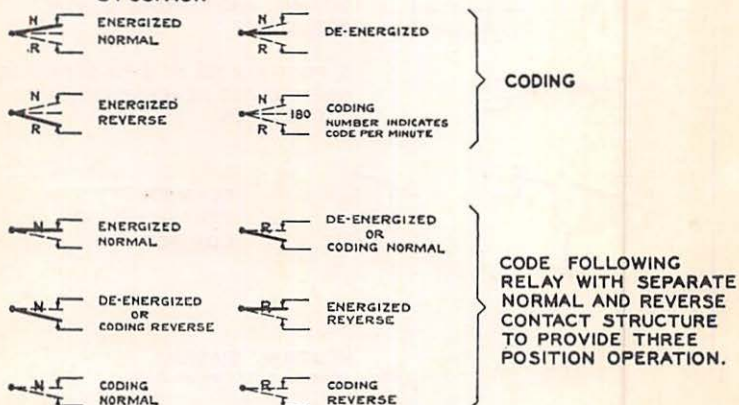


CODING CONTACTS

2 POSITION



3 POSITION



180 DU

DECODING UNIT

NUMBER INDICATES CODE PER MINUTE TO WHICH UNIT IS TUNED.

GRAPHICAL SYMBOLS
RELAY CONTACTSAAR
SIG. SEC.

1674E

M-1543 SEPT-1943 M-1548 SEPT-1948 M-1546 OCT-1946 M-1543 OCT-1943 M-1534 MAR-1934

(Sheet 2 of 3 sheets)

RELAY CONTACTS WITH SPECIAL CHARACTERISTICS

 HIGH CURRENT

 CHECKING CONTACT
FOR TIME ELEMENT RELAY.

 HIGH VOLTAGE

 FRONT
CONTACT ON
INTERLOCKING
RELAY WHICH
REMAINS CLOSED
WITH ARMATURE
IN INTERMEDIATE
POSITION.

 HIGH VOLTAGE AND
HIGH CURRENT

 BACK

 + MAGNETIC BLOWOUT
GRAPHICAL SYMBOLS
RELAY CONTACTSAAR
SIG. SEC.

M- SEPT-1943 M-1948 SEPT-1948 M-1946 OCT-1946 M-1943 OCT-1943 M-1934 MAR-1934

1674E

COOPERATIVE REPORT

PURCHASES AND STORES DIVISION, A.A.R.
GENERAL RECLAMATION COMMITTEE*

C. D. Cronk, Representative

The General Reclamation Committee have had two meetings which were attended by Mr. C. D. Cronk, Signal Section representative. Subject-matter submitted by the Committee for consideration consisted of the following:

New reclamation practices:

Geared hand brakes

Tight lock couplers

Unit type brake beams

Reclaiming silver from Diesel locomotive bushings

The above subjects, after considerable discussion, were approved for inclusion in the Advance Notice for the 1949 Annual Meeting of the Purchases and Stores Division, A.A.R.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
GRAPHICAL SYMBOLS AND ABBREVIATIONS—
PROJECT Z32—SUBGROUP 8B. F. Dickinson, Chairman of Subgroup as Representative of
Engineering Division, A.A.R.

Graphical symbols were prepared for railroad use, except those for electrical and circuit symbols, using A.A.R. and A.R.E.A. symbols in so far as possible. These symbols were forwarded to the Secretary of the American Standards Association by Committee Z32 under date of December 15, 1948 and were acknowledged with advice that as soon as the preliminary draft was printed, copies would be distributed for final checking. To date, copies for final checking have not been received.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, pp. 161 and 361.

COMMITTEE VI—DESIGNS

Personnel

J. C. Lummis, Chairman

W. G. Brown, Vice-Chairman

P. P. Ash	H. P. Schmidt
R. I. Becksted	P. E. Snead
E. F. Brown	H. M. Sova
W. H. Dutton	D. B. Thomas
W. A. Ford	T. W. Tizzard
A. S. Haigh	C. H. Tobin
S. B. Higginbottom	C. N. Tymeson
W. T. Lewis	A. J. Yarrell

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Designs.
4. Specifications and drawings covering reflector lenses and similar devices for signals and signs, collaborating with Committee VIII.
5. Simplification of sizes and kinds of electric lamps for signal purposes, co-operating with Purchases and Stores Division, A.A.R.
6. Specification for concrete, reinforcement and test requirements for pre-cast concrete foundations, monolithic and sectional types.
7. Design a universal switch adjustment bracket.
8. Design a universal adjustment bracket for application of lock rod to front rod.
9. Specification for electric light unit for application to highway crossing gate arms.

The Committee submits for consideration, reports on the following subjects*:

1. Revised drawings.

Drawings to be made obsolete.

Revision of Specification 190-42, Manual Part 166.

Revision of Specification 156-40, Manual Part 43.

Revision of Specification 51-46, Manual Part 91.

Revision of Specification 174-46, Manual Part 12.

3. New drawings.

9. Specification 236-49.

Cooperative report. American Standards Association—Standardization and Unification of Screw Threads—Project B1.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

Explanatory

Specification 156-40, Manual Part 43, has been revised to simplify the language, to eliminate some unnecessary details, and to broaden the scope of the specification to include the necessary practical and technical requirements for both glass and plastic type units.

Section 10-b-1-a, referring to units using glass, remains the same as originally set up for this specification.

Section 10-b-2-a, b and c, covering units using plastic, are new and are presented in the form shown because the former test for glass is not practical for use on plastic. The tests for plastic, however, are well recognized and are commercially practical as referred to in A.S.T.M. Specification D 260, "Method of Test for Color Fastness of Plastics to Light." The A.S.T.M. Specification is a "method test" which, when applied for 50 hours, is considered as equivalent to 100 to 200 hours exposure to sunlight in Washington, D. C. during August and September between the hours of 9:00 a.m. and 4:00 p.m. (The revised specification submitted calls for a test run of 120 hours which is in accordance with the testing procedure used by the U.S. Navy.) In this test method a standard G.E. sun lamp BM-12, or equivalent, with a 15-inch diameter reflector, is used, operated by a standard S-1 bulb with a combination tungsten filament and mercury arc light source consuming 400 watts. The lamp enclosure is made of Corex "D" filter glass which absorbs most of the destructive light rays below 2,800 Angstrom Units. The ultra-violet in sunlight is all above 2,800 Angstrom Units. The test samples are placed on a turntable 7 inches from the sun lamp and rotate at 33 r.p.m. with the room temperature at 77 degrees F. The specimens are observed on the basis of the relative amount of color change under the classification:

- No. 1—None
- No. 2—Slight
- No. 3—Appreciable
- No. 4—Extreme

An "appreciable change" is one which is readily perceptible without close examination but is insufficient to markedly alter the original color of the specimen.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.
A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Disposition of 1948 Letter Ballot Subjects

The following subjects presented by this Committee at the 1948 Annual Meeting were submitted to letter ballot and officially approved:

- A.A.R. Sig. Sec. 1015C—One Inch Signal Pipe and Coupling—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1023D—Guides for Vertical Mechanical Connections for 5 and 6 Inch Masts—Assemblies—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1059C—Clamp for Base of 6 Inch Ground Masts—Details and Assembly—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1083D—Bolt and Clamp for 5-Inch Masts—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1178D—Clamps for Base of 5 Inch Bridge Masts—Details and Assemblies—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1346C—Electric Hand Lantern—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1355C—Crank Bearings and Clamps for Base of 6 Inch Masts—Details and Assemblies—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1357D—Ladders for Ground Masts for Two-Way Signals—Details and Assemblies—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1362D—Ladder Parts—Details—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1363C—Ladder Handrails—Details and Assemblies—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1364D—Ladder Platforms—Details and Assemblies—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1365D—Ladders for Ground Masts with Platforms—Assemblies—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1366D—Ladders for Bridge Masts—Assemblies—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1371D—Ladder Clamps and Stays—Details and Assemblies—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1491D—Highway Crossing Gate Arm—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1583D—Ladders for Ground Masts without Platforms—Assemblies—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1585D—Ladder Parts—Details and Assemblies—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1609B—Electric Hand Lantern Lens—Now in Drawing Section of the Manual.
- A.A.R. Sig. Sec. 1481A—Electric Light Unit—Illuminated Highway Crossing Sign—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1482A—Illuminated Highway Crossing Sign—Front of Mast Mounting for 4 to 8 Inch Pipe—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1483A—Illuminated Highway Crossing Sign—Side of Mast Mounting for 4 to 8 Inch Pipe—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1484A—Adapter Clamp—Illuminated Highway Crossing Sign—Front of Mast Mounting for 4 to 8 Inch Pipe—Now in Drawing Section of Manual.

- A.A.R. Sig. Sec. 1485A—Bracket—Illuminated Highway Crossing Sign—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1486A—Adapter Clamp—Illuminated Highway Crossing Sign—Side of Mast Mounting for 4 to 8 Inch Pipe—Now in Drawing Section of Manual.
- A.A.R. Sig. Sec. 1487A—Signal and Cover Glass Roundels—Illuminated Highway Crossing Sign—Now in Drawing Section of Manual.
- Specification 69-48—Signal Glasses—Now in Manual Part 136.
- Specification 232-48—Electric Light Unit for Highway Crossing Signal—Doublet Lens Type—Now in Manual Part 244.

REVISED DRAWINGS

- A.A.R. Sig. Sec. 1056F—Terminal Blocks—Short Type.
- A.A.R. Sig. Sec. 1077B—Terminal Block—Long Type.
- Drawings harmonized in minimum and maximum widths, glazing, compound, washer-nut assemblies, titles, footnotes and A.A.R. Sig. Sec. 1070G.
- A.A.R. Sig. Sec. 1446C—Electric Light Unit for Semaphore Lighting.
- Title changed. Ordering references removed. Footnotes and drawing details revised.
- A.A.R. Sig. Sec. 1645D—Number of Tracks Sign—Reflector Type for 4 to 8-Inch Pipe—Assembly.
- Title and details changed in accordance with latest practices and arranged together with new drawing, A.A.R. Sig. Sec. 1700A, so that front and back plates may be ordered separately.
- A.A.R. Sig. Sec. 1656D—Cross-Arms for Flashing Light Highway Crossing Signals Without Gates—4 to 8-Inch Pipe—Assemblies.
- A.A.R. Sig. Sec. 1657D—Cross-Arms for Flashing Light Highway Crossing Signals Without Gates—4 to 8-Inch Pipe—Details.
- Drawings revised to permit the use of both threaded and clamp type elbows. Titles and various details revised.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

- A.A.R. Sig. Sec. 1056E—Terminal Blocks.
- A.A.R. Sig. Sec. 1077A—Terminal Block—Long Type.
- A.A.R. Sig. Sec. 1446B—Electric Lamp Case for Semaphore Lighting.
- A.A.R. Sig. Sec. 1645C—Reflector Multiple Track Sign.
- A.A.R. Sig. Sec. 1656C—Junction Box and Cross-Arm Assembly for Flashing Light Highway Crossing Signals.
- A.A.R. Sig. Sec. 1657C—Junction Box and Cross-Arm Details for Flashing Light Highway Crossing Signals for 4, 5, 6, 8 Inch Pipe.

DRAWINGS TO BE MADE OBSOLETE

- R.S.A. 1175—Hydrometer (Stationary Lead Type Storage Battery).
- A.A.R. Sig. Sec. 1375B—Thermometer—Lead Type Storage Battery.
- Drawing 1456—Torque Testing Apparatus.
- A.R.A. Sig. Sec. 1624A—Tension Test Specimen.

As there seems to be no demand for these parts, it is recommended these drawings be removed from the Manual.

Action Recommended

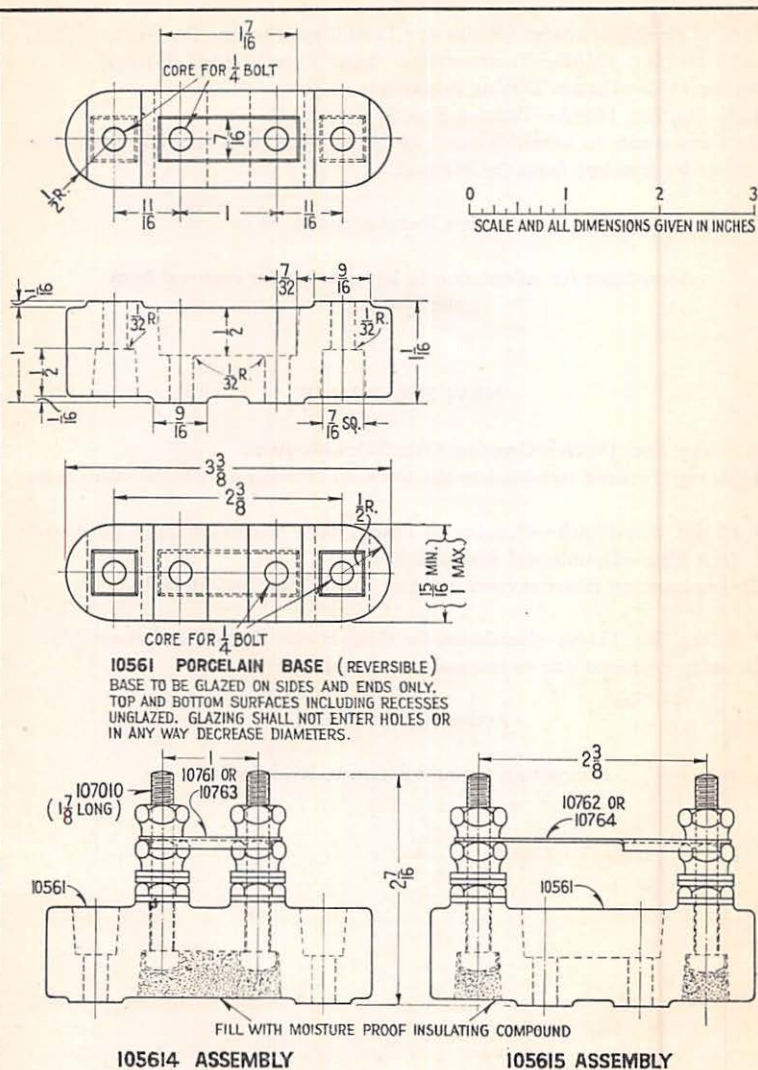
Acceptance for submission to letter ballot for removal from the Manual.

NEW DRAWINGS

- A.A.R. Sig. Sec. 1492A—Crossing Gate Sidewalk Arm.
Drawing prepared to complete the work on crossing gate mechanism arms.
- A.A.R. Sig. Sec. 1700A—Number of Tracks Sign—Reflector Type for 4 to 8-Inch Pipe—Details and Assemblies.
See explanation under revised drawing A.A.R. Sig. Sec. 1645D.
- A.A.R. Sig. Sec. 1710A—Insulation for Gage Rods—Details and Assembly.
Drawing prepared due to increasing demand.

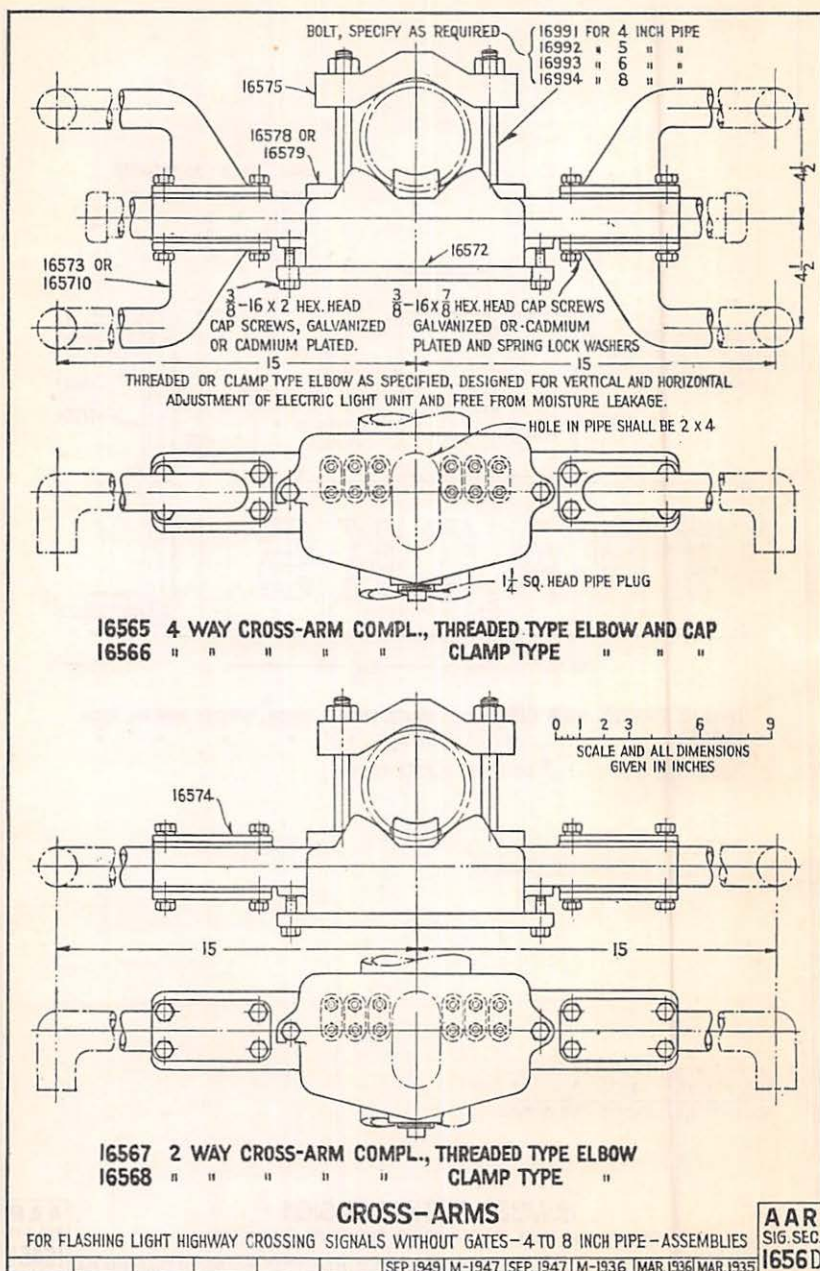
Action Recommended

Acceptance for submission to letter ballot.



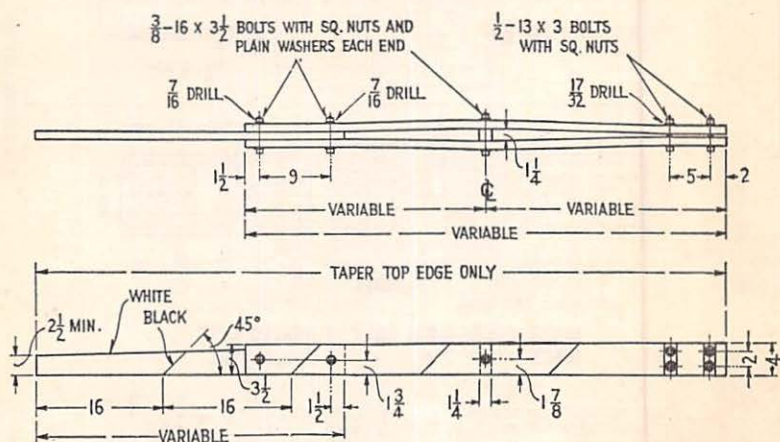
SEP. 1941 | M-1934 | MAR. 1934 | M-1929 | SEPT. 1928 | MAN. 1923 | MAR. 1924 | NOV. 1923 | M-10-1916 | MAY 1915 | M-1-1914 | MAR. 1912

Porcelain shall be in accordance with Specification 144, Manual Part 80.
Insulating compound shall be in accordance with Specification 184, Manual Part 73.

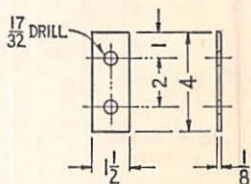
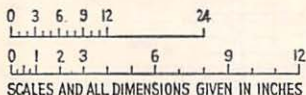


Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17.

Spring lock washers shall be carbon steel (A.S.A. current Specification B27.1 is preferred where practicable).

**14921 CROSSING GATE SIDEWALK ARM, SPECIFY LENGTH.****NOTES:**LUMBER SHALL BE ONE INCH GRADE 'C' SELECT WHITE PINE OR EQUIVALENT
DRESSED FOUR SIDES.

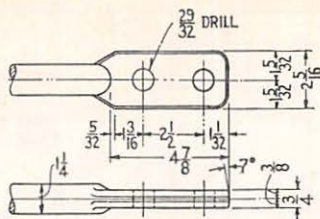
ALL BOLTS, NUTS AND PLAIN WASHERS SHALL BE GALVANIZED OR CADMIUM PLATED.

**14922 WASHER PLATE**C-1020 STEEL
GALVANIZED OR CADMIUM PLATED**CROSSING GATE SIDEWALK ARM**AAR
SIG. SEC.
1492A

SEP. 1949

Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads,
Manual Part 17.

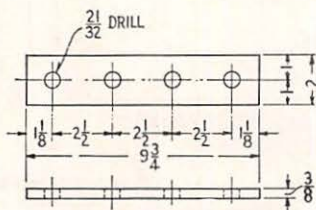
Paint and painting shall be in accordance with Specification 120, Manual Part 110.



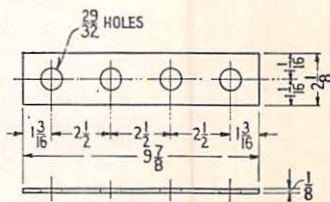
SPLICE END
C-1025 STEEL

NOTE:

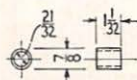
SPLICE ENDS SHALL BE DROP-FORGED WITHOUT WELDS AND EXCESS METAL TRIMMED WHILE HOT.



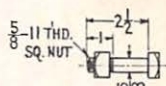
17102 SPLICE PLATE
C-1017 STEEL



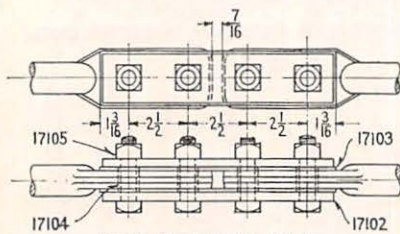
17103 INSULATION PLATE
FIBRE



17104 INSULATION BUSHING
FIBRE



17105 BOLT COMPL.
C-1038 STEEL HEAT-TREATED



17101 INSULATION COMPL.

0 1 2 3 6 9 12
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

DIELECTRIC REQUIREMENTS:

INSULATION COMPLETE SHALL WITHSTAND FOR NOT LESS THAN THREE SECONDS THE APPLICATION OF A POTENTIAL OF 2,000 VOLTS A.C. WITHOUT FLASHOVER OR PUNCTURE BETWEEN ALL METALLIC PARTS AND OTHER METALLIC PARTS INSULATED THEREFROM.

TESTS:

INSULATION AND PARTS SHALL BE IN ACCORDANCE WITH THE FOLLOWING MINIMUM REQUIREMENTS AS TO TENSILE PROPERTIES:

- (a) BOLTS:
- | | |
|--|---------|
| 1 - TENSILE STRENGTH, LBS. PER SQ. IN. | 110,000 |
| 2 - YIELD POINT, " " " " | 80,000 |
| 3 - ELONGATION IN 2 IN., PER CENT. | 14 |
| 4 - REDUCTION IN AREA, " " " | 35 |
- (b) INSULATION COMPLETE:
- | | |
|---|--------|
| 1 - TENSILE STRENGTH, LBS. PER SQ. IN. OF ROD | 50,000 |
|---|--------|

INSULATION FOR GAGE RODS
DETAILS AND ASSEMBLY

AAR
SIG. SEC.
1710A

SEP. 1949

Bolts, nuts and threads shall be in accordance with Specification for Bolts, Nuts and Threads, Manual Part 17.

Assembly and test shall be in accordance with Specification 216, Manual Part 116.

(Revision of A.A.R. Signal Section Specification 190-42)
A.A.R. SIGNAL SECTION SPECIFICATION 190-49.

ELECTRIC LIGHT UNIT FOR HIGHWAY CROSSING SIGNAL REFLECTOR TYPE

1. *Purpose.*

(a) This specification is for the purpose of providing an electric light unit of the reflector type for highway crossing signals. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

- (a) The provisions contained in the alternate requisites section
- of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Detail design of unit shall be approved by Purchaser.

(b) Like parts of same Manufacturer's apparatus shall be interchangeable.

(c) Case and door shall be cast iron, in accordance with A.S.T.M. current Specification A 48, Class 20. *R-6-c.

(d) Case shall be designed for attachment to elbow of cross-arm assembly, Drawing 1656. The door shall open in front and be hinged at the side or bottom.

(e) Case shall be designed to house in a fixed position a glass reflector and associated parts.

* Alternate requisites section.

6. *Design.*—Continued.

(f) Door shall be designed for mounting a suitable roundel as a cover glass to produce the required beam spread.

(g) Two side light openings not less than $1\frac{1}{2}$ in. nor more than 2 inches in diameter, with hoods, and clear glass, shall be provided so that light from the lamp bulb can be directed along the horizontal axis of the unit 90 deg. away from the main indication. *R-6-g.

(h) Case body shall project not more than $3\frac{1}{2}$ in. to the rear of the center line of the supporting fixture.

(i) Case shall be so designed that center of roundel and side lights shall be not less than $7\frac{1}{4}$ in. nor more than $9\frac{3}{4}$ in. below the center of the cross-arm, Drawing 1656.

(j) Door and roundel shall be provided with durable water-proof gaskets which shall be fastened securely in place to prevent the entrance of dust or moisture.

(k) Case shall be so designed that the reflector, roundel and associated parts may be cleaned without disturbing the adjustment of the optical system.

(l) Door shall provide:

1. Means for compressing the door against the housing.

2. A locking lug with minimum opening of $\frac{1}{2}$ in. for application of lock. *R-6-l-2.

3. Easy access to all parts when open.

(m) Case shall be designed with wire entrance at point of attachment to elbow of cross-arm assembly, Drawing 1656.

(n) A breather opening with suitable filter shall be provided at bottom of case.

(o) Machine screws, washers, bolts, nuts, and hinge pins shall be of corrosion-resisting metal or suitably plated after threads have been cut. Zinc or cadmium shall not be used on parts carrying current.

7. *Terminals and wiring.*

(a) Terminals in the case shall be conveniently located and shall be mounted on insulating block or blocks.

(b) Flexible copper wires not less than No. 18 A.W.G. single-conductor, suitably insulated, shall be provided between lamp receptacle and terminals and be securely fastened to prevent breakage.

(c) Wire eyelets or connectors shall be provided on each wire attached to binding posts.

8. *Roundels.*

(a) Roundels shall be highway crossing red, $8\frac{3}{8}$ inches in diameter, convex, and shall be in accordance with Specification 69, Manual Part 136.

* Alternate requisites section.

8. *Roundels*.—Continued.

(b) Roundels shall be as specified by Purchaser, with range pattern per sections 13-c and 13-d, as follows (*R-8-b):

1. Thirty deg. horizontal spreadlight type with 15 deg. downward deflection.
2. Seventy deg. horizontal spreadlight type without downward deflection.
3. Twenty deg. horizontal spreadlight type with 32 deg. downward deflection.
4. Diffusion-deflection type, with horizontal and downward spread.

9. *Lamp receptacle*.

(a) Case shall be provided with a single-contact candelabra bayonet lamp receptacle designed for electric lamps having a light center length of $1\frac{1}{4}$ in. The receptacle shall be adjusted on a rigid support and sealed in position at the factory so that a $\frac{1}{8}$ in. precision based lamp will have its filament at the focal point of the reflector. Receptacle shall be insulated from the case and reflector support. *R-9-a.

10. *Reflector*.

(a) The reflector shall be of glass of the Mangin or parabolic type and shall have a reflecting surface of proper diameter to project substantially parallel light rays in a cylindrical beam equal to the effective diameter of the roundel used.

(b) The reflector shall be constructed as follows:

1. The reflective backing shall consist of a heavy homogeneous coating of pure metallic silver, evenly applied. The coating shall be applied over clean smooth glass, and shall be applied in such a manner that no foreign substance remains between it and the glass. The coating shall adhere firmly and so closely to the glass that the admission of any foreign substance will be prevented.

2. Over the silver there shall be applied electrolytically a heavy coat of metallic copper of such thickness as to reinforce the silver reflective backing and protect it from atmospheric conditions. The copper shall extend over the edge of the mirror at least one-fourth the thickness of the glass. Over the copper backing shall be placed one or more coats of paint or enamel of such quality as to render the greatest resistance possible to the admission of moisture or gases. The paint or enamel shall withstand ordinary handling without scratching or chipping.

3. In addition to the protective coating of copper and enamel, the reflector shall be mounted in a metal cover to prevent mechanical injury and sealed to provide protection to the backing from moisture. *R-10-b-3.

* Alternate requisites section.

11. *Reflector tests.*

(a) Two reflectors, selected at random from each lot of 100 or fraction thereof, before mounting in metal cover, shall meet the following test:

1. The reflector shall be immersed for 24 hours at room temperature in a solution composed of clean water and 20 per cent by weight of salt. It shall then be removed from the salt solution and rinsed in clean water, after which it shall be placed in clean water at room temperature and gradually heated to a temperature of 170 deg. F. and maintained at that temperature for 4 hours. The reflector shall then be removed from the water and placed in dry air at 170 deg. F. for 4 hours.

2. After this test, the backing on the reflector shall show no chipping, cracking or softening of the coatings and shall show no separation of the backing into layers, or from the mirror surface, and no appreciable change in the color of the backing or the silver reflecting surface.

12. *Background and hood.*

(a) Background shall be provided, having 20 in. diameter and made of copper-bearing sheet steel suitably treated to resist corrosion, and shall be not less than 0.045 in. thick. Design shall be such that it can be mounted on the unit in the field without use of special tools.

(b) A hood shall be provided, made of copper-bearing sheet steel suitably treated to resist corrosion, and shall be not less than 0.0375 in. thick and not less than 10 in. long, projecting substantially at right angles to the body of the case.

(c) Hood shall extend one-half way around the lens opening and be designed to minimize the likelihood of snow or ice accumulating on the roundel.

13. *Range and spread.*

(a) Range shall be the distance at which under bright sunlight conditions, with the sun at or near the zenith, the indication will be clear and distinct to a person with normal vision.

(b) Range shall be determined when the light unit is operated with a 10-volt 10-watt single-filament lamp of 1,000 hours design life burning at 10 volts.

(c) For mast-mounted signals at standard height, 7 to 9 ft.:

1. When equipped with a 30 deg. horizontal spread, 15 deg. downward deflection roundel, the range shall be:

	Ft.
On the axis.....	1,500
5 deg. either side of axis.....	1,500
10 deg. either side of axis.....	1,500
15 deg. either side of axis.....	500

13. *Range and spread.*—Continued.

2. When equipped with a 70 deg. horizontal spreadlight roundel without downward deflection, the range shall be:

	Ft.
On the axis.....	1,500
5 deg. either side of axis.....	1,300
10 deg. either side of axis.....	900
15 deg. either side of axis.....	700
20 deg. either side of axis.....	600
25 deg. either side of axis.....	500
30 deg. either side of axis.....	300
35 deg. either side of axis.....	200

(d) For cantilever-mounted signals and mast-mounted signals higher than 9 ft.:

1. When equipped with a 20 deg. horizontal spread, 32 deg. downward deflection roundel, the range shall be:

	Ft.
On the axis.....	1,500
5 deg. either side of axis.....	1,500
10 deg. either side of axis.....	1,000

2. When equipped with a diffusion-deflection roundel, the range in feet shall be:

Degrees below the axis	Degrees either side of axis					
	Axis	2	5	10	15	20
Axis	1,300	900	500			
2	1,100	900	600			
4	900	900	750			
6	900	900	900	850	800	650
8	700	700	700	700	600	500
10	400	400	400	400	350	
12	300	300	300	300	300	

14. *Painting.*

(a) Case shall be painted with a first coat of red lead primer or equivalent inside and out, in accordance with Specification 120, Manual Part 110, and with a finish coat of non-reflecting black on the inside and on the front exposed portion in accordance with Specification 214, Manual Part 221.

(b) Hood and background shall be painted with a first coat of red lead primer or equivalent and with a finish coat of non-reflecting black in accordance with Specification 120, Manual Part 110.

15. *Phantom.*

(a) Each lamp unit shall be so constructed that a suitable device can be added in the field to minimize the effect of illumination by reflection from external light.

16. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010 or 107020.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts, and spaced not less than 1 in. centers.

17. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom, except the lamp receptacle which shall withstand for one minute an insulation test of 800 volts a.c.

(b) With the exception of the lamp receptacle, a surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

18. *Identification.*

(a) Case or door shall be plainly marked with Manufacturer's name or trade-mark.

19. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

20. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

21. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

22. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-6-c.

Case and door shall be:

1. Cast aluminum alloy in accordance with A.S.T.M. current Specification B 26. Aluminum base alloy sand castings. Alloy number and treatment as required.

2. Die alloy in accordance with A.S.T.M. current Specification B 86. Zinc base alloy die castings. Alloy number as required.

R-6-g.

Side light openings shall be blanked.

R-6-l-2.

Locking lug shall not be provided.

R-8-b.

Roundels shall be as specified by the Purchaser, with range pattern having horizontal spread and downward deflection.

R-9-a.

Lamp receptacle shall be adjusted on a rigid support and locked in position at the factory without sealing.

R-10-b-3.

Reflector shall be provided without metal cover.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 190-42—Flashing Light Signal Lamp Unit, Manual Part 166.

(Revision of A.A.R. Signal Section Specification 156-40)
A.A.R. SIGNAL SECTION SPECIFICATION 156-49.

REFLECTOR UNIT

1. *Purpose.*

(a) This specification is for the purpose of providing a reflector unit for reflector signs for railroad highway grade crossing protection. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

3. *Type.*

(a) Reflector units shall be suitable for mounting to front plates of signs shown on Drawings 1642, 1645, 1646, 1648 and 1692.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *Design.*

(a) The reflector unit shall be of substantial design, accurately formed, constructed for correct focus and proper assembly to the specified signs.

(b) The lens element shall have an adequately sealed enclosure to protect the reflecting surface.

(c) The lens element, complete with its sealed enclosure, shall be assembled into a corrosion-resisting metal retainer, suitable for mounting in the apertures in front plates of signs as specified on drawings.

(d) The lens element may be of crystal clear glass in combination with a suitable reflector, or of crystal clear acrylic plastic accurately formed with prismatic internal reflecting surfaces.

6. *Lens.*

(a) The lens shall be practically free from chromatic aberration when viewed within an angle of 25 deg. from its axis.

(b) The lens shall be so designed that a light at any point within 25 deg. of the axis of the lens will be reflected to a point 40 in. above the source with satisfactory intensity. The source of light shall be an approved type of automobile headlight and shall be located 300 ft. from reflector unit.

7. Mounting.

(a) The reflector unit shall be held in a fixed relation to the face of sign with its axis normal to the aperture.

(b) Mounting shall be designed to prevent removal of reflector units from front of assembled sign.

(c) The reflector unit shall be so constructed that the metal retainer or housing shall in no way affect the legibility or the effectiveness of the sign.

(d) The reflector unit shall be so designed that fittings and housing parts will not loosen or break due to crystallization or fatigue when subjected to vibration in service.

8. Inspection.

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

9. Tests.

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

(e) The following tests shall be made:

1. Resistance to shock.
2. Effect of solarization.
3. Resistance to corrosion.
4. Integrity of sealing.
5. Observation.

(f) Sampling.

1. One hundred reflector units will be selected by the Purchaser at random from a lot of at least 1,000.

2. From the group of 100 units, 25 will be selected at random for tests.

10. *Description of tests.*

(a) Shock resistance test. (For glass units only.)

1. The complete reflector units shall be mounted in a sign plate in the manner in which they are to be used and subjected to the following shock resistance test: The entire assembly shall be reduced to a temperature of 33 deg. F., at which temperature a 1 lb. steel weight in the form of a piece of round steel bar stock $\frac{3}{4}$ inch in diameter and 8 in. long, with its striking end cut square, shall be dropped on the center of each unit successively through a tube having an inside diameter of $\frac{7}{8}$ in. from a height of 18 in. During this test, the sign plate in which the units are mounted shall be backed in the vicinity of the units with a solid metal mass. Units shall then be examined for lens fracture or damage to metal parts; if any evidence of failure appears, the lot represented by the samples shall be rejected.

(b) Solarization.

1. Reflector units using glass shall be tested as follows:

(a) The reflector units shall be exposed for 84 hours at a distance of 9 in. to the radiation from a quartz mercury arc lamp operated at 450 watts across the tube by mounting them in a sheet metal cylinder surrounding and co-axial with the center line of the lamp. The temperature of this metal cylinder shall be maintained at 120 deg. F. After exposure, reflector units shall then be examined for discoloration of the lens element due to solarization; if any appears, the lot represented by the samples shall be rejected.

2. Reflector units using plastic shall be tested as follows:

(a) The method of test shall be as specified in A.S.T.M. Specification D 260-45T, Method of Test for Color Fastness of Plastics to Light.

(b) Tests shall be made for 120 hours at room temperature of 77 deg. F.

(c) If any of the samples show an appreciable change in color as defined in the test specification, the lot represented by the sample shall be rejected.

(c) Corrosion test.

1. The complete reflector units with mounting accessories as used in the sign shall be sprayed with a 20 per cent salt-water solution for 24 hours. Reflector units shall then be examined for evidence of corrosion; if any appears, the lot represented by the samples shall be rejected.

(d) Integrity of sealing.

1. A suitable container shall be filled with water one-half to one-third its depth, after which the reflector units are immersed therein, and the lid firmly fastened. A vacuum equal to a 10-inch column of mercury is created within the container and allowed to remain for 10 minutes, after which

10. *Description of tests.*—Continued.

atmospheric pressure is restored and the lid removed. The units are permitted to remain in the water for 10 minutes, then removed and examined for leakage. Leakage shall not be evident on more than 2 per cent of the units.

(e) *Observation test.*

1. The reflector units shall be taken in groups of 10, placed in a metal strip 2 in. apart, center to center. These strips shall then be taken one at a time and observed to see if the reflector units meet the requirements of section 6-b; if not, the lot represented by the samples shall be rejected.

11. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

12. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

13. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within two years after shipment to the Purchaser. This warranty shall not apply to any apparatus which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 156-40—Reflector Unit, Manual Part 43.

BEAM SPREAD OF DEFLECTING LENSES
ON HIGHWAY CROSSING SIGNALS

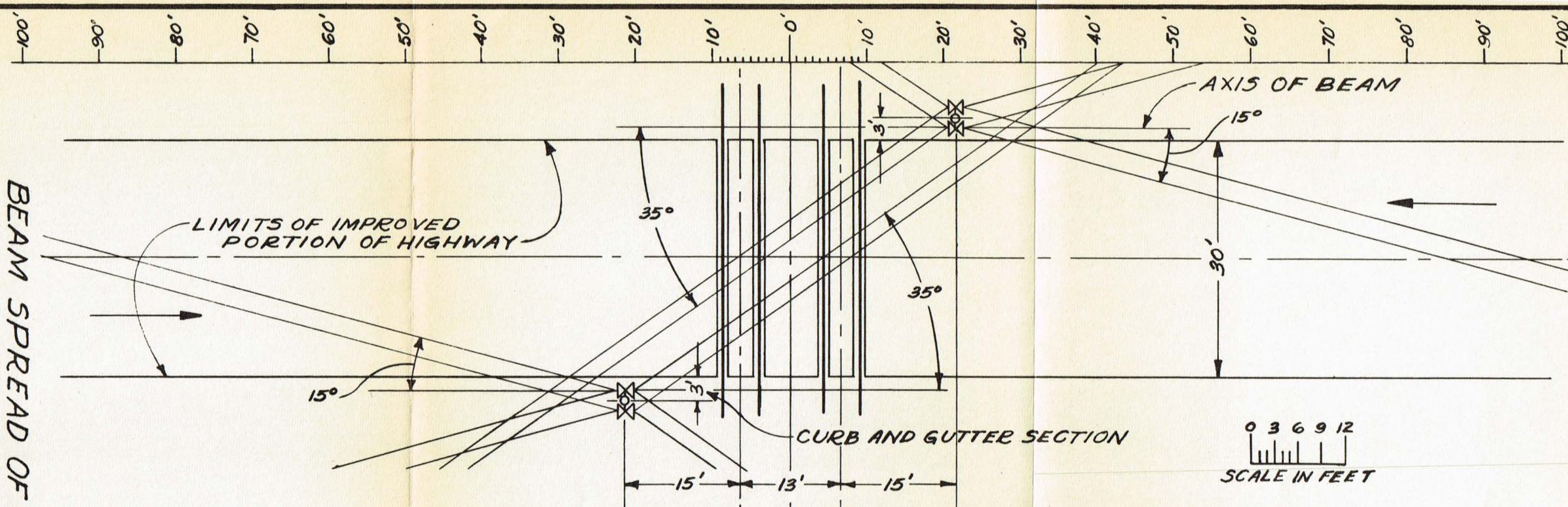


FIGURE 1 - SIGNALS ON STRAIGHT MAST

AREA OF HIGHWAY COVERED BY HORIZONTAL LIGHT BEAM FROM SIGNALS HAVING FRONT LIGHTS EQUIPPED WITH 30° SPREADLIGHT LENS AND BACK LIGHTS WITH 70° SPREADLIGHT LENS. AXIS OF BEAM INTERSECTING CENTER OF HIGHWAY APPROACH 1500' FROM CROSSING.

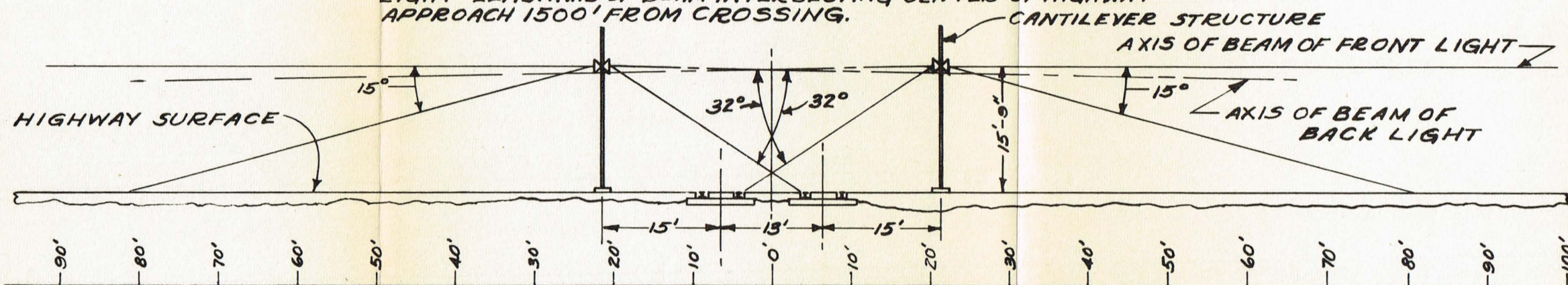


FIGURE 2 - SIGNALS ON CANTILEVER STRUCTURE

AREA OF HIGHWAY COVERED BY DOWNWARD DEFLECTED LIGHT BEAM FROM SIGNALS HAVING FRONT LIGHTS EQUIPPED WITH 15° DOWNWARD DEFLECTING LENS, WITH AXIS OF BEAM INTERSECTING CENTER OF HIGHWAY APPROACH 1500' FROM CROSSING; AND BACK LIGHTS WITH 32° DOWNWARD DEFLECTING LENS, WITH AXIS OF BEAM INTERSECTING CENTER OF HIGHWAY APPROACH 750' FROM CROSSING.

(Revision of A.A.R. Signal Section Specification 51-46)
A.A.R. SIGNAL SECTION SPECIFICATION 51-49.

INCANDESCENT ELECTRIC LAMPS

Revision of the Appendix to this Specification is submitted on pages 299-307, in accordance with the policy set up to bring this subject-matter up-to-date triennially.

The following progress has been made in greater universal use of lamps in the more active groups and the elimination of those in the lower activity groups:

<i>Progress</i>	<i>Total lamps</i>
1938 Purchases and Stores Division, A.A.R. Original List.....	350
1939 Annual Meeting Advance Notice, Signal Section, A.A.R.:	
Active, 172; Non-active, 21.....	193
1949 Annual Meeting Advance Notice, Signal Section, A.A.R.:	
Active, 132; Non-active, 14.....	146

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Appendix of Specification 51-46—Incandescent Electric Lamps,
Manual Part 91.

APPENDIX

SIMPLIFICATION AND STANDARDIZATION OF INCANDESCENT
ELECTRIC LAMPS FOR RAILROAD SIGNAL PURPOSES

This list has been compiled to encourage the use of lamps in the more active group ratings, and the elimination as far as practicable of those in the lower activity groups.

ACTIVITY GROUP BASED ON PERIOD 1946-1949.

		No. of items
1	1,000 or more lamps sold per year	54
2	500 to 1,000 " " " "	14
3	25 to 500 " " " "	58
4	0 to 25 " " " "	6
0	No " " " "	14
		146 Total

Symbols, Abbreviations and Notes Pertaining to Activity Group Tables

SOURCE:

W—Westinghouse Lamp Co.
G—General Electric Co.
GRS—General Railway Signal Co.
US&S—Union Switch & Signal Co.
WE—Western Electric Co.
PC. No.—Piece Number
Dwg. No.—Drawing Number

ELECTRICAL:

A—Amperes
W—Watts
CP—Spherical Candlepower

BULB:

Shape—See current A.A.R. Sig. Sec. 1541
Color—Clear unless otherwise noted
Atmosphere—Gas unless otherwise noted
✱—Vacuum

BASE (See current A.A.R. Sig. Sec. 1542):

B.MIN—Bayonet miniature, single contact
SC—Bayonet candelabra, single contact
DC—Bayonet candelabra, double contact
S.MIN—Screw miniature
S.CAN—Screw candelabra
S.MED—Screw medium
2-PS—Rebased with 2 pin sleeve (US&S)

BASE—Continued:

- 3-PS—Rebased with 3 pin sleeve (GRS)
- 1825—Used with 2 and 3 pin sleeve
- SL.1—Slide telephone switchboard type (902, W-G-GRS)
- SL.2—Slide telephone switchboard type (WE-US&S)

FILAMENT:

- MF—Major filament
- SF—Secondary filament
- Shape—See current A.A.R. Sig. Sec. 1543
- INV.—Inverted
- Note—Plane of base pins at right angles to plane of filament unless otherwise noted
- ⊖—Plane of base pins parallel to plane of filament
- LCL—Light center length in inches
- Tolerance—Plus-minus dimensions in inches allowed on LCL and AA (axial alignment). Where two dimensions are shown the first applies to LCL and the second to AA. Where no tolerance is shown, Manufacturer's standard to apply.
- Material—Tungsten unless otherwise noted under MF

LIFE HOURS:

Manufacturer's laboratory rated average burning hours of a group of lamps tested under specified test conditions.

MANUFACTURERS' DESIGNATION:

- RLS—Railroad light signal, visible day and night indication
- RS—Railroad signal, visible night indication only

RAILROAD USE:

- SEM—Semaphore signal
- CLT—Color light signal
- PLT—Position light signal
- CPLT—Color position light signal
- SLT—Searchlight signal
- TO—Train order signal
- XNG—Highway crossing signal
- IND—Indicator
- LL—Lever light
- CTI—Chart track indicator (includes C.T.C.-NX-UR)
- SL—Switch lamp
- CGA—Crossing gate arm

Note.—

Tables are revised triennially and lamps shown in the 0 group removed. Current 0 group lamps have been delisted by the Manufacturers and discontinued, except where they are used for purposes other than signal work.

ACTIVITY GROUP TABLE INCANDESCENT ELECTRIC LAMPS FOR RAILROAD SIGNAL PURPOSES

LAMPS SOLD PER YEAR 25 TO 500

GROUP 3—CONTINUED

Item No.	Source			Amps. Watts CP	Volts	Bulb	Base	Filament				Life Hours	Mfr. Desg.	Railroad Use	Principal Railroads Using
	GRS Dwg. No.	WE W-G	US&S PC. No.					Major Sec.	Shape	LCL	Tolerance				
337		W-G		15W	115	S-11	SC	✦	C-7A			750		SEM	CB&Q
338		W-G		15W	125	S-11	SC	✦	C-7A			750		SEM	C&NW
339		W-G		5W	32	S-14	S. Med	✦	S-1	2½		1,500	RS	SEM	AT&SF
340		W-G	188835	10W	64	S-14	S. Med	✦	C-9	2½	¾	1,500	RS	SEM (Subway)	NYC
341	52879	W-G		.17-.21A	4	T-2	SL.1	✦	C-6				4A	CTI	C&O
342		WE	240191	.12-.16A	6	T-2	SL.2	✦	C-21				E-3	CTI	NYC
343	52879-12	WE	240192	.085-.10A	8	T-2	SL.2	✦	C-21				G-1	CTI	MP-AT&SF-UP
344		WE	240193	.23-.27A	10	T-2	SL.2	✦	C-21				J-1	CTI	SP-CRI&P-StLSF-SAL-ACL-CB&Q-CMS&P
345	52879-1	W-G		.09-.11A	12	T-2	SL.1	✦	C-21				12-A	CTI	B&M-C&NW-L&N-LV-NP
346		WE	240186	.103-.120A	15	T-2	SL.2	✦	Carbon				2-C	CTI	CRI&P
347	52879-3	W-G		.09-.11A	16	T-2	SL.1	✦	C-21				16A	CTI	NP
348		WE	240195	.033-.045A	24	T-2	SL.2	✦	C-21				A-1	CTI	MP
349		WE	240188	.075-.115A	24	T-2	SL.2	✦	Carbon					CTI	AT&SF-B&M
350	52879-5	W-G		.09-.11A	24	T-2	SL.1	✦	C-21				24D	CTI	CB&Q-Sou-StLSF
351	52879-9	W-G		.09-.11A	24	T-2	SL.1	✦	C-21	Red coating				CTI	LV-D&H
352		WE	240197	.032-.044A	36	T-2	SL.2	✦	C-21				C-2	CTI	PRR-ACL
353		W-G	209679	.17A	14	T-3	B. Min	✦	C-2V	5/8		250		IND-CTI	CNJ-StLSF
354		W-G	209711	.17A	14	T-3	B. Min	✦	C-2V	5/8	Red coating	250		IND-CTI	CNJ-StLSF
355	43198-17	W-G		.15A	6-8	T-3¼	S. Min	✦	C-2R	Yellow coating		3,000		CTI	GTW-T&P
356	43198-18	W-G		.15A	6-8	T-3¼	S. Min	✦	C-2R	Red coating		3,000		CTI	GTW-T&P
357	43198-22	W-G		.15A	6-8	T-3¼	S. Min	✦	C-2R	Green coating		3,000		CTI	GTW-T&P
358	57026-2	W-G		.015A	14	T-3¼	B. Min	✦	C-2R	5/8		200	No. 1488	CTI	B&O

ACTIVITY GROUP TABLE INCANDESCENT ELECTRIC LAMPS FOR RAILROAD SIGNAL PURPOSES

LAMPS SOLD PER YEAR 0 TO 25

GROUP 4

Item No.	Source			Amps. Watts CP	Volts	Bulb	Base	Filament				Life Hours	Mfr. Desg.	Railroad Use	Principal Railroads Using
	GRS Dwg. No.	WE W-G	US&S PC. No.					Major Sec.	Shape	LCL	Tolerance				
401		W-G	80837	29W	6	G-16½	SC		C-2R	1⅝	¼	3,000	RLS	CLT	DL&W
402	45772	G		11W	14	S-8	S. Min	Carbon single loop						LL	LV
403	37751	G		10W	125	S-8	S. Can	✱Carbon	5TCir					LL	L&N
404	34866-55	W-G		5W	8	S-11	SC		C-2R	1¼	¼	1,000	RLS	CLT-XNG	DM&IR
405	34866-44	W-G		18W	8	S-11	SC		C-2R	1¼	¼	1,000	RLS	CLT-XNG	T&P
406	43198-11	W-G		.15A	6-8	T-3¼	S. Min	✱	C-2R	1⅝		3,000	No. 40	IND	T&P-CB&Q

6. *Design.*—Continued.

(f) Provision shall be made for attaching a sighting device which, when attached, shall be in correct alignment with the axis of the light beam.

(g) Door and roundel shall be provided with durable, water-proof gaskets, which shall be fastened securely in place to prevent the entrance of dust or moisture.

(h) Cover shall provide:

1. Means for compressing the cover against the housing.
2. Easy access to all parts when open.

(i) Machine screws, washers, bolts, nuts and hinge pins shall be of corrosion-resisting metal or suitably plated after threads have been cut. Zinc or cadmium shall not be used on parts carrying current.

7. *Roundels.*

(a) Roundels shall be flat, clear, double strength plain glass, $5\frac{3}{8}$ in. diameter. *R-7-a.

8. *Candlepower.*

(a) Reflector assembly without roundel shall project a concentrated light beam of 8,000 candlepower on the axis when lighted with an 8-volt 5-watt electric lamp, 1,000 hours design life, operated at 7.2 volts.

9. *Binding posts.*

(a) Binding posts, nuts and washers shall conform to Drawing 1070, assembly 107010 or 107020.

(b) Binding posts shall be mounted so they cannot be turned in the base or frame to which applied. They shall be properly insulated from each other and other metallic parts, and spaced not less than 1 in. centers.

10. *Reflector.*

(a) The reflector shall be constructed of glass and shall have an active reflecting surface of 5 inches in diameter. *R-10-a.

(b) The reflective backing shall consist of a homogeneous coating of pure metallic silver, evenly applied. The coating shall be applied over clean smooth glass and shall be applied in such a manner that no foreign substance remains between it and the glass. The coating shall adhere firmly and so closely to the glass that the admission of any foreign substance will be prevented.

(c) Over the silver there shall be applied, electrolytically, a coat of metallic copper of such thickness as to reinforce the silver reflective backing and protect it from atmospheric conditions. The copper shall extend over the edge of the mirror at least one-fourth the thickness of the glass. Over the copper backing shall

* Alternate requisites section.

10. Reflector.—Continued.

be placed one or more coats of paint or enamel of such quality as to render the greatest resistance possible to the admission of moisture or gases which might injure the copper or silver backing. The paint or enamel shall withstand ordinary handling without scratching or chipping.

(d) In addition to the protective coating of copper and enamel, the reflector shall be mounted in a metal cover to prevent mechanical injury and sealed to provide protection to the backing from moisture. *R-10-d.

11. Reflector tests.

(a) Two reflectors selected at random from each lot of 100 or fraction thereof, before mounting in metal cover, shall stand the following test:

1. The reflector shall first be immersed for 24 hours at room temperature in a solution composed of tap water and 20 per cent by weight of salt. It shall then be removed from the salt solution and rinsed in clean water, after which it shall be placed in clean water at room temperature. This bath with the reflector shall then be gradually heated to a temperature of 170 deg. F. and maintained at that temperature for 4 hours. After that heating, the reflector shall be removed from the water and placed in dry air at 170 deg. F. for 4 hours.

(b) After the above test, the backing on the reflector shall show no chipping, cracking or softening of the coatings and shall show no separation of the backing into layers or from the mirror surface and no appreciable change in the color of the backing or the silver reflecting surface.

12. Dielectric requirements.

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom, except the lamp receptacle which shall withstand for one minute an insulation test of 800 volts a.c.

(b) With the exception of the lamp receptacle, a surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

13. Identification.

(a) Case or door shall be plainly marked with Manufacturer's name or trade-mark.

* Alternate requisites section.

14. *Paint and painting.*

(a) Paint and painting shall be in accordance with Specification 120, Manual Part 110. Inside and outside shall be painted black.

15. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

16. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

17. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

18. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment.

19. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective

19. *Warranty.*—Continued.

within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-7-a.

Roundel shall be:

1. Convex clear double strength plain glass, $5\frac{3}{8}$ in. diameter.
2. Convex clear spreadlight type, $5\frac{3}{8}$ in. diameter, in accordance with Specification 69, Manual Part 136.
3. Convex clear plain molded glass, $5\frac{3}{8}$ in. diameter, in accordance with Specification 69, Manual Part 136.

R-10-a.

The reflector shall be constructed of glass and shall have an active reflecting surface of inches in diameter.

R-10-d.

Reflector shall be provided without metal cover.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 174-46—Electric Lamp Case, Manual Part 12.

A.A.R. SIGNAL SECTION SPECIFICATION 236-49.

ELECTRIC LIGHT UNIT FOR HIGHWAY CROSSING GATE ARM

1. *Purpose.*

(a) This specification is for the purpose of providing an electric light unit for application to highway crossing gate arms. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Drawings.*

(a) Purchaser's drawings referred to in this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. *Tender.*

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

4. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

5. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

6. *Design.*

(a) Detail design of unit shall be approved by Purchaser.

(b) Like parts of same Manufacturer's apparatus shall be interchangeable.

(c) Unit shall be suspended from a bracket allowing free movement to maintain the same vertical axis throughout the movement of gate arm.

(d) Unit body shall be constructed of aluminum or other suitable lightweight material. When cast aluminum is used, alloy shall be in accordance with A.S.T.M. current Specification B 26.

(e) Means shall be provided for easy removal of electric lamp.

(f) Unit body shall be provided with suitable shields, easily removable, and adjustable for preventing display of light in the direction of approaching trains.

6. *Design.*—Continued.

(g) Unit body shall be provided with a candelabra bayonet lamp receptacle on non-adjustable support, for electric lamps having a light center length of $1\frac{1}{4}$ in., a single-contact base and a suitable bulb.

1. Receptacle shall be insulated from the unit body.

2. Receptacle shall be adjusted in position at the place of manufacture so that a $\frac{1}{64}$ in. precision based lamp will have its filament at the focal point of the lens.

(h) Unit body shall be so designed that the lens may be cleaned or replaced without disturbing the adjustment of the optical system.

(i) Assembly, including wire outlet, shall be provided with durable waterproof gaskets, which shall be fastened securely in place to prevent the entrance of dust or moisture.

(j) Unit body shall be provided with insulated flexible copper wire leads of not less than No. 16 A.W.G. and of suitable length for connection to gate arm wiring.

1. Internal connections to lamp receptacle shall be soldered and suitably insulated.

(k) Lens shall be of the 360 deg. Fresnel type, inside diameter not to exceed 3 in. and height not to exceed $3\frac{1}{2}$ in.

(l) Bracket for supporting the electric light unit shall be designed for rigidly fastening to the gate arm with not less than two bolts. Bracket shall extend above the gate arm a sufficient distance to provide a clearance of not less than 3 in. between the top of the gate arm and the bottom of the light unit when the gate arm is horizontal.

1. Bracket shall be provided with suitable means for holding lead wires in place.

(m) Bracket, bolts, washers and machine screws shall be of corrosion-resisting metal or suitably plated to resist corrosion. Zinc or cadmium shall not be used on parts carrying current.

7. *Dielectric requirements.*

(a) Electrical apparatus assembled shall withstand for one minute an insulation test, at place of manufacture, of 3,000 volts a.c. between all parts of electric circuits and other metallic parts insulated therefrom, except the lamp receptacle which shall withstand for one minute an insulation test of 800 volts a.c.

(b) With the exception of the lamp receptacle, a surface leakage distance of not less than $\frac{1}{4}$ in. shall be provided between any exposed metallic part of the apparatus carrying current and any other metallic part thereof.

8. *Paint and painting.*

(a) Unit body shall be suitably painted or otherwise treated to resist corrosion.

9. *Lenses.*

(a) Lenses shall be in accordance with Specification 69, Manual Part 136.

(b) Color shall be highway crossing red. *R-9-b.

10. *Identification.*

(a) Unit body shall be plainly marked with Manufacturer's name or trade-mark.

11. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

* (b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Manufacturer, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Manufacturer shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production it shall be so stated on Purchaser's order.

12. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Manufacturer shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Manufacturer shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

13. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

14. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment.

* Alternate requisites section.

15. *Warranty.*

(a) Manufacturer shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Manufacturer's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-9-b.

Color shall be electric lantern red.

Action Recommended

Acceptance for submission to letter ballot.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
SECTIONAL COMMITTEE ON THE STANDARDIZATION AND
UNIFICATION OF SCREW THREADS—PROJECT B1*

W. G. Brown, Representative

The following is material taken from "Standardization," Vol. 20, No. 1, January 1949 issue, page 4, published by the American Standards Association:

A declaration of accord was signed November 18, 1948 by delegations of Canada, the United Kingdom, and the United States, agreeing that the standards for unified screw threads given in the publications of the British Standards Institution, Canadian Standards Association, American Standards Association and the Interdepartmental Screw Thread Committee fulfill all the basic requirements for general interchangeability of threaded products made in accordance with these standards.

The unified system has been approved by the American groups through the A.S.A. Sectional Committee on the Standardization and Unification of Screw Threads, B1, which developed it from the American point of view. The Committee is sponsored by the American Society of Mechanical Engineers and the Society of Automotive Engineers. The new proposal was developed as a revision of the American Standard approved in 1935.

The three principal characteristics of screw threads are angle and form of

* Previous report on Project B1 appears in A.A.R. Signal Section 1944 Proceedings, Vol. XLII, pp. 185-A and 265-A.

thread, the number of threads per inch for the various series of thread diameters, and the tolerances and allowances (or limiting dimensions on sizes of threads) for the three classes of thread fits ("loose," "medium," and "close").

The British system, originated by Whitworth in 1845, is based on a thread angle of 55 degrees with a thread form having rounded crests and roots. The American system, developed by Sellers in 1864, has a thread angle of 60 degrees with a thread form having flat crests and roots. The number of threads per inch for the various series of thread diameters is the same in both systems, with the exception of the half-inch coarse thread. These differences between the systems made trouble because accurate fits between components having different thread angles is impossible; moreover, tolerances and allowances vary.

The unification agreement provides a 60-degree angle and a rounded root for the threads. The crest of the thread may be flat, as preferred in American practice, or rounded, as preferred by the British. The number of threads per inch for the various series of thread diameters above $\frac{1}{4}$ inch has been unified, except for $\frac{1}{2}$ inch, where the American Standard will include both the 12 thread UC and the 13 inch NC, and the limiting dimensions for three classes of fit have been agreed upon.

Sectional Committee B1 took part in the negotiations leading to the above agreement.

Action Recommended

Acceptance as information.

COMMITTEE VII—MATERIALS RESEARCH

Personnel

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T. T. Hart	P. A. Starck
W. W. Hartzell	G. E. Tracey

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Investigate and report on the various types of lubricants used in car retarders, and prepare specifications where necessary.
4. Investigate and report on rust preventives.
5. Investigate and report on frost preventives.
6. Investigate and report on means for determining colors for target enamel covered in Specification 227, Manual Part 235, and prepare recommended colors.
7. Investigate and report on the possibilities of plastics as a substitute for other materials in signal work.
8. Investigate and report on the use of stainless steel guy and messenger strand.
9. Specification for paint for finishing coats on wood structures.
10. Specification for paint for finishing coats on steel and iron structures.
11. Specification for enamel for finishing coats on wood structures.
12. Investigate and report on a substitute for wood for use on electric crossing gate arms.
13. Investigate and report on the specification of SAE 1335 steel for rods or plates, Drawings 1256C or 1587B or similar, where field setting of such rods or plates may be necessary.
14. Investigate and report on test installations of aluminum or newer or better steel alloys for relay and instrument housings.

The Committee submits for consideration, reports on the following subjects*:

1. Revision of Specification for Electrolyte, Manual Part 13.
Revision of Specification 53-39, Manual Part 18.
Revision of Specifications for Various Types of Non-Ferrous Metals and Alloys, Manual Part 220.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

3. Various types of lubricants used in car retarders.
Specification 250-49.
 4. Rust preventives.
 8. Use of stainless steel guy and messenger strand.
 9. Specification 251-49.
 10. Specification 252-49.
 11. Specification 253-49.
- Cooperative report. American Standards Association—Electrical Insulating Materials in General—Project C59.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.
A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Disposition of 1948 Letter Ballot Subjects

The following subjects presented by this Committee at the 1948 Annual Meeting were submitted to letter ballot and officially approved:

- Specification 120-48—Paint and Painting—Now in Manual Part 110.
Specification 237-48—Enamel Primer Paint for Steel and Iron Structures—
Now in Manual Part 245.
Specification 238-48—Primer Paint for Wood Structures—Now in Manual
Part 246.
Specification for Lubricant for Use in Electro-Pneumatic Valves and
Cylinders—Now in Manual Part 247.
Requisites for Minimizing Condensation and Front Conditions—Now in
Manual Part 188.
Specifications for Various Types of Steel—Now in Manual Part 154.

A.A.R. SIGNAL SECTION SPECIFICATION 251-49.

PAINT FOR FINISHING COATS ON WOOD STRUCTURES

1. *Purpose.*

(a) This specification is for the purpose of providing paint for finishing coats on wood structures. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material meeting the requirements of this specification in its entirety.

3. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *General.*

(a) The Manufacturer is given latitude in the selection of raw materials and processes of manufacture provided the product meets the requirements of this specification in its entirety.

(b) Material shall be suitable for application by brushing or spraying.

(c) Material shall be suitable for application over primer paint, Specification 238, Manual Part 246. *R-5-c.

6. *Composition.*

(a) Material shall be an oil-base paint, meeting the requirements of section 4.

(b) Material shall contain a minimum of 3.75 lbs. of raw and bodied drying oils per gallon and suitable volatile thinners and driers.

(c) Pigment shall be of such quality and proportion to provide a paint which will meet the requirements of section 7.

* Alternate requisites section.

7. Requirements.

(a) Color.

1. The color shall be as specified by the Purchaser.

(b) Consistency.

1. Material shall be of brushing consistency in the packaged condition and shall be such that, when thinned according to the recommendations of the Manufacturer of the material, it shall be suitable for use by spraying.

(c) Dilution stability.

1. When material is thinned according to the instructions of the Manufacturer of the material and allowed to stand in a well-stoppered glass bottle for at least one hour at a temperature of 77 deg. F., the thinner shall not cause the precipitation or separation of any ingredient of the material or affect the quality of the applied coating. (Slight settling of pigment is not considered objectionable.)

(d) Packaging properties.

1. Material shall show no objectionable settling nor skinning in a freshly opened full can of age not exceeding 6 months, and shall be easily mixed to a homogeneous state with a paddle.

2. After 30 days' standing at room temperature, a half-filled, tightly closed 1 quart container of the material shall show no livering, curdling or lumps and shall show no more settling than can be easily and readily broken up with a paddle and redispersed. Skinning, if present, shall be of the firm, continuous variety, easily removable.

(e) Drying.

1. When applied at film thickness of 1 mil, to wood test panels prepared in accordance with A.S.T.M. current Specification D 358 and having primer coating in accordance with section 6-e-1 of Specification 238, Manual Part 246, the applied coating shall dry sufficiently for a succeeding coat in not more than 24 hours. All drying shall be conducted in a well-ventilated chamber free from drafts and dust, but not in the direct rays of the sun, maintained at temperatures between 70 and 80 deg. F., and with relative humidity of 40 to 60 per cent.

(f) Appearance.

1. Coated panels, after drying, shall present a smooth, uniform appearance, reasonably free of floating, streaking, differences in gloss, and application defects such as sagging, etc. No roughness such as unground pigment or skin particles shall be detectable by visual inspection.

(g) Hiding power.

1. Complete visual hiding power shall be obtained when applied over black and white contrasting stripes to a dry film thickness of not exceeding 2 mils.

7. *Requirements.*—Continued.

(h) Adhesion.

1. When a film of the material is applied to test panels prepared as in section 7-e-1, air-dried one week, the film when cut with a sharp knife to form an X, shall show no loss of adhesion or peeling between the lines of the cuts.

(i) Weathering.

1. Panels prepared and coated as in section 7-e-1, shall be air-dried one week, then subjected to weathering per A.S.T.M. current Specification D 822 for 150 hours in a standard carbon arc and waterspray weathering machine.

2. After weathering, the film shall not show evidence of crazing, blistering, peeling, excessive color change, excessive chalking, or other film failure.

8. *Application.*

(a) Application of paint for finishing coats on wood structures shall be in accordance with Specification 120, Manual Part 110.

9. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production, it shall be so stated on Purchaser's order.

10. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

11. *Shipping containers.*

(a) Paint and thinner shall be available in containers specified by the Purchaser as follows:

1. Paint in 1 and 5 gallon cans, and in drums.
2. Volatile thinner in 1 pint, 1 quart, and 1 gallon cans.

12. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

13. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment.

14. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within three months after shipment to the Purchaser. This warranty shall not apply to any material which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-5-c.

Material shall be suitable for application over primer coat of

.....
Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 252-49.

PAINT FOR FINISHING COATS ON STEEL
AND IRON STRUCTURES1. *Purpose.*

(a) This specification is for the purpose of providing paint for finishing coats on steel and iron structures. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material meeting the requirements of this specification in its entirety.

3. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *General.*

(a) The Manufacturer is given latitude in the selection of raw materials and processes of manufacture provided the material meets the requirements of this specification in its entirety.

6. *Requirements.*(a) *Color.*

1. The color shall be as specified by the Purchaser and shall be non-bleeding.

(b) *Consistency.*

1. Material shall be of brushing consistency in the packaged condition and shall be such that when thinned in accordance with the recommendation of the Manufacturer of the material, it shall be suitable for dipping or spraying.
*R-6-b-1.

(c) *Dilution stability.*

1. When material is thinned in accordance with the instructions of the Manufacturer of the material and allowed to stand in a well-stoppered glass bottle for at least one hour

* Alternate requisites section.

6. *Requirements.*—Continued.

at a temperature of 77 deg. F., the thinner shall not cause the precipitation or separation of any ingredient of the material or affect the quality of the applied coating. (Slight settling of pigment is not considered objectionable.)

(d) Packaging properties.

1. The material shall show no objectionable settling or skinning in a freshly opened full can of age not exceeding 6 months, and shall be easily mixed to a homogeneous state with a paddle.

2. After 30 days' standing at room temperature, a half-filled, tightly closed 1 quart container of the material shall show no livering, curdling, or lumps and shall show no more settling than can be easily and readily broken up with a paddle and redispersed. Skinning, if present, shall be of the firm, continuous variety, easily removable.

(e) Drying.

1. Material, when air-dried on test panels prepared in accordance with A.S.T.M. current Specification D 358, shall dry sufficiently for a succeeding coat in not more than 24 hours. All drying shall be conducted in a well-ventilated chamber free from drafts and dust, but not in the direct rays of the sun, maintained at temperatures between 70 and 80 deg. F., and with relative humidity of 40 to 60 per cent.

(f) Appearance.

1. Coated panels after drying shall present a smooth, uniform appearance, reasonably free of floating, streaking, differences in gloss and application defects such as sagging, etc. No roughness such as unground pigment or skin particles shall be detectable by visual inspection.

(g) Hiding power.

1. Complete visual hiding power shall be obtained when applied over black and white contrasting stripes to a dry film thickness of not exceeding 2 mils.

(h) Adhesion and flexibility.

1. Adhesion and flexibility shall be checked on a film of the material applied on test panels prepared as in section 6-e-1, air-dried 24 hours, followed by baking for 48 hours at 150 deg. F. The material shall adhere tightly and, when the film is scratched with a sharp knife held at an approximate angle of 30 deg. with the panel, shall show bevelled edges and flakes shall not form or fly.

(i) Weathering.

1. Panels prepared and coated as in section 6-e-1, shall be air-dried one week, then subjected to weathering per A.S.T.M. current Specification D 822 for 150 hours in a standard carbon arc and waterspray weathering machine.

2. After weathering, the film shall not show evidence of crazing, blistering, peeling, excessive color change, excessive chalking, or other film failure.

7. *Application.*

(a) Application of paint for finishing coats shall be in accordance with Specification 120, Manual Part 110.

8. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production, it shall be so stated on Purchaser's order.

9. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

10. *Shipping containers.*

(a) Paint and thinner shall be available in containers specified by the Purchaser as follows:

1. Paint in 1 and 5 gallon cans, and in drums.
2. Volatile thinner in 1 pint, 1 quart and 1 gallon cans.

11. *Packing.*

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

12. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment.

13. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within three months after shipment to the Purchaser. This warranty shall not apply to any material which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-6-b-1.

The material shall be of $\left\{ \begin{array}{l} \text{dipping} \\ \text{spraying} \end{array} \right\}$ consistency.

Action Recommended

Acceptance for submission to letter ballot.

A.A.R. SIGNAL SECTION SPECIFICATION 253-49.

ENAMEL PAINT FOR FINISHING COATS
ON WOOD STRUCTURES1. *Purpose.*

(a) This specification is for the purpose of providing enamel paint for finishing coats on wood structures. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. *Tender.*

(a) The tender shall be for material meeting the requirements of this specification in its entirety.

3. *Alternates.*

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by Purchaser's order for the provisions contained in this specification.

4. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

5. *General.*

(a) The Manufacturer is given latitude in the selection of raw materials and processes of manufacture provided the material meets the requirements of this specification in its entirety.

(b) Material shall be suitable for application by brushing or spraying.

6. *Requirements.*(a) *Color.*

1. The color shall be as specified by the Purchaser and shall be non-bleeding.

(b) *Consistency.*

1. Material shall be of brushing consistency in the packaged condition and shall be such that when thinned in accordance with the recommendation of the Manufacturer of the material, it shall be suitable for spraying. *R-6-b-1.

* Alternate requisites section.

6. *Requirements.*—Continued.

(c) Dilution stability.

1. When material is thinned in accordance with the instructions of the Manufacturer of the material and allowed to stand in a well-stoppered glass bottle for at least one hour at a temperature of 77 deg. F., the thinner shall not cause the precipitation or separation of any ingredient of the material or affect the quality of the applied coating. (Slight settling of pigment is not considered objectionable.)

(d) Packaging properties.

1. Material shall show no objectionable settling or skinning in a freshly opened full can of age not exceeding 6 months, and shall be easily mixed to a homogeneous state with a paddle.

2. After 30 days' standing at room temperature, a half-filled, tightly closed 1 quart container of the material shall show no livering, curdling, or lumps and shall show no more settling than can be easily and readily broken up with a paddle and redispersed. Skinning, if present, shall be of the firm, continuous variety, easily removable.

(e) Specular gloss.

1. Panels for gloss test shall conform to A.S.T.M. current Specification D 609.

(a) Panels shall be given one spray coat of primer.

(b) Primer shall be air-dried to the hard stage before applying coat of material to be tested.

(c) Coating material to be tested shall be applied in one coat by spraying to provide an air-dried film thickness of 1 mil.

2. Test panels prepared in accordance with section 6-e-1, coated and dried in accordance with section 6-f-1, and tested in accordance with A.S.T.M. current Specification D 523, Procedure A, shall have a value of 70 minimum.

(f) Drying.

1. Material, when air-dried on test panels prepared as in section 6-e-1, shall dry sufficiently for a succeeding coat in not more than 12 hours. All drying shall be conducted in a well-ventilated chamber free from drafts and dust, but not in the direct rays of the sun, maintained at temperatures between 70 and 80 deg. F., and with relative humidity of 40 to 60 per cent.

(g) Appearance.

1. Coated panels after drying shall present a smooth, uniform appearance, reasonably free of floating, streaking, differences in gloss and application defects such as orange peel, sagging, etc. No roughness such as unground pigment or skin particles shall be detectable by visual inspection.

(h) Hiding power.

1. Complete visual hiding power shall be obtained when applied over black and white contrasting stripes in 1.5 mils

6. *Requirements.*—Continued.

dry film thickness for all pigmentation except lead chromate pigments or organic pigments in which 2.5 mils shall give complete hiding.

(i) Adhesion and flexibility.

1. Adhesion and flexibility shall be checked on a film of the material applied on test panels prepared as in section 6-e-1, air-dried 12 hours followed by baking for 48 hours at 150 deg. F. The material shall adhere tightly and, when the film is scratched with a sharp knife held at an approximate angle of 30 deg. with the panel, shall show bevelled edges and flakes shall not form or fly.

(j) Weathering.

1. Test panels prepared as in section 6-e-1, air-dried 12 hours followed by baking for 24 hours at 150 deg. F., then subjected to weathering as per A.S.T.M. current Specification D 822 for 150 hours in a standard carbon arc and waterspray machine shall show no evidence of crazing, blistering, peeling or excessive fading or chalking.

7. *Application.*

(a) Application of enamel finishing coat shall be in accordance with Specification 120, Manual Part 110.

8. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production, it shall be so stated on Purchaser's order.

9. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

10. *Packing.*

(a) Enamel and thinners shall be available in 1 quart containers and shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

11. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment.

12. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within three months after shipment to the Purchaser. This warranty shall not apply to any material which has been subjected to misuse, negligence or accident.

Alternate requisites.

R-6-b-1.

Material shall be of spraying consistency.

Action Recommended

Acceptance for submission to letter ballot.

VARIOUS TYPES OF LUBRICANTS USED IN CAR RETARDERS

Assignment 3 required the investigation of various types of lubricants for a specific purpose, that is, the lubrication of car retarders. However, the various types of lubricants for car retarders may be found suitable for use in other types of signal apparatus, also lubricants for use in other signal apparatus may be satisfactory for use in the lubrication of car retarders, which has been definitely disclosed by the investigation of the Committee.

The lubricants used in car retarders may be enumerated as follows:

1. Pressure gun grease for pins and bearings.
2. Grease for electro-pneumatic valves and cylinders.
3. Oil for sliding surfaces.
4. Oil for pins and bearings.
5. Oil for electric motor bearings.
6. Grease for gear cases.

Under Item 1, the Committee is submitting Specification 250-49—Pressure Gun Grease. This specification covers a grease suitable for the lubrication of pins and bearings of car retarders; however, it is also suitable for other signal apparatus where the correct type of lubrication fittings are provided. The Committee, therefore, departed from the investigation of lubricants for car retarders and included in the purpose of Specification 250-49, "signal apparatus as recommended by the manufacturer of the apparatus."

Under Item 2, the Committee submitted at the 1948 Annual Meeting, Specification for Lubricant for Use in Electro-Pneumatic Valves and Cylinders. Lubricant in accordance with this specification meets the requirements for valves and cylinders in connection with other signal apparatus as well as car retarders.

Under Items 3, 4, 5 and 6, investigation indicates that there is no particular requirement for specifications covering lubricants for the specific purposes outlined. The lubricants now in use are generally satisfactory and in most cases are used in small quantities; however, it should be remembered when selecting a lubricant that a cheap oil will often result in greatly increasing other expenses, hence quality and adaptability for the service required are the most important considerations. In connection with Items 4 and 5, the Committee recommends that on signal apparatus or mechanisms equipped with ring type ball bearings or roller type bearings, graphite grease or graphite impregnated oil should not be used.

Action Recommended

Acceptance as information.

A.A.R. SIGNAL SECTION SPECIFICATION 250-49.

PRESSURE GUN GREASE

1. *Purpose.*

(a) This specification is for the purpose of providing a grease suitable for application, by means of either hand or power-operated pressure guns, to car retarders and other signal apparatus as recommended by the manufacturer of the apparatus. It sets forth specific detailed requirements representing modern signal practice.

2. *Tender.*

(a) The tender shall be for material meeting the requirements of this specification in its entirety.

3. *Material and workmanship.*

(a) Material and workmanship shall be first-class in every respect.

(b) The grease shall be a homogeneous combination of refined mineral oil and lime soap, compounded in such a way as to obtain a minimum degree of separation of the constituents over long periods of time either in storage or in use, and shall not harden with age or exposure. It shall not contain any gritty substance, graphite or any fillers such as clay, talc, mica or gypsum. It shall not corrode metals under normal operating conditions.

(c) The grease shall conform to the following requirements:

1. Mineral oil: 89 per cent by weight, minimum.
2. Lime soap: 11 per cent by weight, maximum.
3. Moisture: 1.5 per cent maximum.
4. Corrosive compounds: None.
5. Free acid as oleic: 0.3 per cent, maximum.
6. Uncombined alkali as calcium hydroxide: 0.15 per cent, maximum.
7. Consistency: Unworked at zero deg. F., 280-340.
8. Freezing: The grease shall not freeze or become solid at minus 30 deg. F.

(d) The mineral oil used shall conform to the following requirements:

1. Flash: 350 deg. F., minimum.
2. Fire: 390 deg. F., minimum.
3. Pour point: Minus 15 deg. F., maximum.
4. Viscosity: S.U. at 100 deg. F., 275-500 seconds.

4. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

4. *Inspection.*—Continued.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production, it shall be so stated on Purchaser's order.

5. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

(e) All tests shall be made in accordance with current A.S.T.M. methods except test for freezing:

1. Analysis—A.S.T.M. D 128.
2. Consistency—A.S.T.M. D 217.*
3. Viscosity—A.S.T.M. D 88.
4. Pour point—A.S.T.M. D 97.
5. Free acid and uncombined alkali—A.S.T.M. D 128.
6. Moisture—A.S.T.M. D 95.
7. Corrosive compounds—A.S.T.M. D 130.**
8. Flash and fire—A.S.T.M. D 92.

(f) Test for freezing shall be conducted as follows:

1. Fill an A.S.T.M. pour test jar ($1\frac{1}{4}$ in. diameter, 5 in. high) up to the graduation line ($2\frac{1}{8}$ in. from the bottom) with the grease to be tested. Insert an A.S.T.M. low cloud and pour test thermometer. Cool this jar and a brass rod $\frac{1}{4}$ in. diameter by suitable means to minus 30 deg. F., and hold at this temperature for at least one hour. Withdraw the thermometer and insert in its place the brass rod. If the rod can be moved through the grease, the grease is considered as not being frozen or solid at this temperature.

* A.S.T.M. D 217 shall be followed except that grease, containers and cone shall be held at zero deg. F. for one hour prior to test. Three separate test containers of the sample shall be tested and the three results averaged.

** Test for corrosive compounds similar to test for corrosive compounds in gasoline.

6. Packing.

(a) Grease shall be furnished in clean, dry containers with tight replaceable covers. Containers shall be so packed as to permit convenient handling and to protect against loss or damage during shipment.

7. Marking.

(a) Purchaser's order, requisition and package number, name of Consignor and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

8. Warranty.

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within 60 days after shipment to the Purchaser. This warranty shall not apply to any material which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot.

(Revision of Specification for Electrolyte)

SPECIFICATION FOR ELECTROLYTE

1949

The recommended specification for electrolyte, for use in lead acid type storage battery for signaling, shall meet current Federal Specification O-A-111 for Acid: Sulphuric, (For) Storage Batteries.

Unless otherwise specified, the specific gravity of electrolyte shall be 1.220 at 77 deg. Fahrenheit.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification for Electrolyte, Manual Part 13.

(Revision of A.A.R. Signal Section Specification 53-39)
A.A.R. SIGNAL SECTION SPECIFICATION 53-49.

LEAD ACID STATIONARY STORAGE BATTERY

Positive Plates of Composite Structure Supporting Active Material in the Form of Pure Lead

1. Purpose.

(a) This specification is for the purpose of providing a composite plate type stationary storage battery cell in sealed-in glass jar. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing material when general renewal or replacement becomes desirable.

2. Tender.

(a) The tender shall be for material, design and assembly meeting the requirements of this specification in its entirety.

3. Material and workmanship.

(a) Material and workmanship shall be first-class in every respect.

4. General.

(a) The capacity shall be designated as:

Ampere hours		
40	160	480
60	200	560
80	240	640
100	280	800
120	320	960
140	400	

These terms shall be understood to signify on an 8-hour basis the capacities thus designated in this specification.

(b) Each cell, unless otherwise specified, shall include the following parts:

1. One positive group consisting of the necessary number of plates assembled with connecting strap and pillar post.
2. One negative group consisting of the necessary number of plates assembled with connecting strap and pillar post.
3. One connecting bolt for each pillar post.
4. One set of separators consisting of one slotted plastic and one grooved wood separator between each positive and negative plate.

4. *General.*—Continued.

5. One inter-cell connector.
6. One glass jar with sealed cover and vent plug.
7. Necessary electrolyte.

5. *Elements.*

- (a) Positive plates shall consist of a pure lead-antimony alloy grid securely supporting cylindrical forms of pure lead and shall have the active material electro-chemically formed.
- (b) Negative plates shall be made with the active material securely supported in a lead-antimony grid.
- (c) Plates shall be connected into positive and negative groups by securely burning to lead-antimony alloy connecting straps, which shall be cast in one piece with the pillar post.
- (d) Pillar post shall extend through cover and shall be fastened thereto. An effective seal shall be provided between cover and pillar post to retard seepage of electrolyte.
- (e) The elements shall be supported on two glass ribs molded in the bottom of each jar.

6. *Separators.*

- (a) Separators shall be of such quality, material and design as to avoid the necessity of replacement during the life of the elements.
- (b) Separators shall be made of:
 1. Specially selected tough acid-resisting porous grooved wood, treated so that all injurious substances are removed.
 2. Precisely slotted plastic, inert to the action of electrolyte.
- (c) Separators shall be so designed as to permit free circulation of the electrolyte between the plates.
- (d) Separators shall be of sufficient size to extend beyond the perimeter of the plates and shall be supported in a substantial manner so as to remain in place.

7. *Jars.*

- (a) Jars shall be of glass, rectangular, free from flaws of a detrimental nature, properly annealed and of a design that permits the application of a cover properly sealed thereto.
- (b) Jars shall be of such size and shape that the over-all dimensions of the cell (including terminal posts) for capacities indicated, shall not exceed the following:

Ampere-hour capacity	Over-all cell dimensions in inches		
	Length	Width	Height
40	$3\frac{1}{16}$	$7\frac{13}{16}$	$12\frac{5}{8}$
60	$3\frac{7}{8}$	$7\frac{13}{16}$	$12\frac{5}{8}$
80	$4\frac{11}{16}$	$7\frac{13}{16}$	$12\frac{5}{8}$
100	$5\frac{1}{2}$	$7\frac{13}{16}$	$12\frac{1}{2}$
120	$6\frac{5}{16}$	$7\frac{13}{16}$	$12\frac{1}{2}$

7. *Jars*.—Continued.

Ampere-hour capacity	Over-all cell dimensions in inches		
	Length	Width	Height
140	$7\frac{1}{8}$	$7\frac{13}{16}$	$12\frac{1}{2}$
160	$7\frac{5}{16}$	$7\frac{13}{16}$	$12\frac{1}{2}$
200	$6\frac{1}{8}$	$9\frac{15}{16}$	$15\frac{1}{4}$
240	$6\frac{7}{8}$	$9\frac{15}{16}$	$15\frac{1}{4}$
280	$7\frac{3}{4}$	$9\frac{15}{16}$	$15\frac{1}{4}$
320	$8\frac{5}{8}$	$9\frac{15}{16}$	$15\frac{1}{4}$
400	$10\frac{3}{8}$	$9\frac{15}{16}$	$15\frac{1}{4}$
480	$12\frac{1}{8}$	$9\frac{15}{16}$	$15\frac{1}{4}$
560	8	$13\frac{5}{16}$	$19\frac{9}{16}$
640	$8\frac{7}{8}$	$13\frac{5}{16}$	$19\frac{9}{16}$
800	$10\frac{5}{8}$	$13\frac{5}{16}$	$19\frac{9}{16}$
960	$12\frac{3}{8}$	$13\frac{5}{16}$	$19\frac{9}{16}$

(c) Jars shall be so constructed on the bottom that they will rest evenly on a horizontal plane without rocking.

(d) A line shall be provided on each end of the jar to indicate the low level of the electrolyte.

(e) Jars shall be of such quality and thickness as to provide an excess of strength necessary to support the elements and withstand ordinary handling.

8. *Covers*.

(a) Covers shall be made of insulating material designed to prevent sagging and shall be free from circuit leakage, impurities detrimental to the plates or separators, and impervious to absorption of electrolyte.

(b) Covers shall be so designed as to provide for an effective seal between cover and jar by the application of suitable sealing compound, and shall be free from rough edges.

9. *Vent plugs*.

(a) A suitable filling hole shall be located in the cover and shall be provided with a removable screw or bayonet type plug so vented that gas will readily escape without carrying entrained electrolyte.

(b) Vent plugs shall be of such design that permits ready removal and replacement, and not easily displaced in shipping or handling.

10. *Connectors*.

(a) Inter-cell connectors shall be flexible, corrosion-resisting, and free from soldered or sweated joints.

(b) Inter-cell connectors shall have a carrying capacity for 8-hour discharge rate without heating or offering abnormal resistance at any discharge rate the cell is designed to deliver.

11. *Sealing compound.*

(a) Sealing compound shall be of acid-proof material which will readily adhere to the glass jar and cover and shall contain no ingredients injurious to the cell.

(b) Sealing compound shall be such that it will not crack in service at 25 deg. F. below zero nor be soft enough to run at 150 deg. F.

12. *Electrolyte.*

(a) Electrolyte shall be dilute sulphuric acid, 1.200 to 1.220 specific gravity at 77 deg. F. when the cell is fully charged, and shall be in accordance with Specification for Electrolyte, Manual Part 13.

13. *Assembly and charge.*

(a) Cell shall be completely assembled, sealed and charged, ready for service.

(b) A name plate of suitable size shall be permanently and uniformly secured to each cell, upon which shall be legibly impressed information as to type and capacity.

(c) The date of shipment shall be legibly impressed on the negative terminal post of each cell.

14. *Inspection.*

(a) Purchaser may inspect material at all stages of manufacture.

(b) Purchaser may inspect the completed product to determine that the requirements of this specification have been met.

(c) If material has not been accepted at point of production and if, upon arrival at destination, it does not meet the requirements of this specification, it may be rejected, and the Contractor, upon request, shall advise the Purchaser what disposition is to be made of the rejected material. Contractor shall pay all freight charges.

(d) If Purchaser is to make inspection at point of production, it shall be so stated on Purchaser's order.

15. *Tests.*

(a) Tests may be made at point of production, or on samples submitted, and may also be made at destination.

(b) Contractor shall give the Purchaser sufficient notice of time when material will be ready for testing.

(c) Contractor shall provide, at point of production, apparatus and labor for making required tests under supervision of the Purchaser.

(d) If tests are to be made at point of production, it shall be so stated on Purchaser's order. The Purchaser shall indicate which of the tests herein specified are to be made and what portion of the material shall be tested.

15. Tests.—Continued.

(e) The following test shall be made at the option of the Purchaser on 10 per cent of the number of cells ordered. The cells shall be selected by the Purchaser from the proposed shipment and shall, after being fully charged, be discharged and charged as follows:

Normal capacity, ampere hours	Discharge for 8-hour rate, amperes
40	5.0
60	7.5
80	10.0
100	12.5
120	15.0
140	17.5
160	20.0
200	25.0
240	30.0
280	35.0
320	40.0
400	50.0
480	60.0
560	70.0
640	80.0
800	100.0
960	120.0

1. Discharge at 8-hour rate to minimum final voltage of 1.75 volts per cell.

2. Charge at 8-hour rate for a period of 20 per cent longer than the duration of the previous discharge.

3. After charging, again discharge at 8-hour rate to a minimum final voltage of 1.75 volts per cell.

4. Recharge at 8-hour rate for a period of 20 per cent longer than the duration of the previous discharge.

5. Electrolyte temperature at beginning of discharge shall be 80 deg. F. maximum with ambient temperature from 5 to 10 deg. F. lower and held within these limits during the test discharge.

6. During each charge and discharge the current shall be held constant at the value specified.

7. Cells shall show 85 per cent or more of their rated capacity under this test.

8. The voltage on discharge shall be measured while current is flowing.

16. Packing.

(a) Material shall be so prepared as to permit convenient handling and to protect against loss or damage during shipment.

17. *Marking.*

(a) Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of package.

(b) Detail list of loose pieces, containers and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

18. *Warranty.*

(a) Contractor shall warrant the material covered by this specification to be free from defects in material and workmanship under ordinary use and service, his obligation under this warranty being limited to manufacturing, at point of production, any part or parts to replace those which shall be found defective within one year after shipment to the Purchaser. This warranty shall not apply to any apparatus which shall have been repaired or altered in any way by anyone other than the Manufacturer thereof, so as to affect, in the Contractor's judgment, its proper functioning or reliability, or which has been subjected to misuse, negligence or accident.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specification 53-39—Lead Acid Stationary Storage Battery,
Manual Part 18.

(Revision of Specifications for Various Types of Non-Ferrous Metals and Alloys)

SPECIFICATIONS FOR VARIOUS TYPES OF NON-FERROUS METALS AND ALLOYS

1949

The recommended specifications for various types of non-ferrous metals and alloys shall meet the requirements of current specifications of the American Society for Testing Materials, for applications as follows:

1. Binding posts and screws with cold upset heads and rolled threads:
 - (a) B 98 —Copper-Silicon Alloy Rods, Bars, and Shapes, Type B, extra-hard, bolt temper.
 - (b) B 164 —Nickel-Copper Alloy Rods and Bars, Class A, cold-drawn.
2. Binding posts and screws, machine-cut:
 - (a) B 98 —Copper-Silicon Alloy Rods, Bars, and Shapes, Type D, hard temper.
 - (b) B 164 —Nickel-Copper Alloy Rods and Bars, Class B, cold-drawn.
 - (c) B 140 —Hardware Bronze Rods, Bars, and Shapes, Type B, half-hard temper.
3. Nuts for binding posts and general purposes:
 - (a) B 16 —Free-Cutting Brass Rod and Bar for Use in Screw Machines, half-hard temper.
4. Machine-cut screws other than for use as binding posts:
 - (a) B 139 —Phosphor Bronze Rods, Bars, and Shapes, grade as required. (For screws, shafts, bushings, trunnions and other structural parts.)
 - (b) B 140 —Hardware Bronze Rods, Bars, and Shapes, Type B, half-hard temper.
 - (c) B 16 —Free-Cutting Brass Rod and Bar for Use in Screw Machines, half-hard temper. (Not to be used for securing vital parts.)
5. Commercial screws with cold upset head and rolled threads:
 - (a) B 134 —Brass Wire, Alloy No. 7, eighth hard temper.
6. Washers for use on binding posts:
 - (a) B 152 —Copper Sheet, Strip, and Plate, Type ETP cold-rolled hard temper.
7. General purpose washers and structural parts:
 - (a) B 97 —Copper-Silicon Alloy Sheet and Strip for General Purposes, type and temper as required.
 - (b) B 127 —Nickel-copper Alloy Plate, Sheet, and Strip, finish and temper as required.

7. General purpose washers and structural parts—Continued:

- (c) B 36 —Brass Sheet and Strip, alloy number and temper as required.
- (d) B 152 —Copper Sheet, Strip, and Plate, type and temper as required.
- (e) B 122 —Copper-Nickel-Zinc and Copper-Nickel Alloy Sheet and Strip, alloy number and temper as required.
- (f) B 103 —Phosphor Bronze Sheet and Strip, grade and temper as required.
- (g) B 209 —Aluminum and Aluminum Alloy Sheet and Plate, alloy number and temper as required.
- (h) B 211 —Aluminum and Aluminum-Alloy Bars, Rods and Wire, alloy number and temper as required.
- (i) B 194 —Beryllium Copper Alloy Strip.

8. Spring contacts:

- (a) B 103 —Phosphor Bronze Sheet and Strip, grade and temper as required.
- (b) B 122 —Copper-Nickel-Zinc and Copper-Nickel Alloy Sheet and Strip, alloy and temper as required.
- (c) B 162 —Nickel Plate, Sheet, and Strip, temper as required.

9. Connectors:

- (a) B 152 —Copper Sheet, Strip, and Plate, Type ETP temper as required.

10. Coiled springs:

- (a) B 159 —Phosphor Bronze Wire, grade and temper as required.
- (b) B 197 —Beryllium Copper Alloy Wire.

11. Die castings:

- (a) B 85 —Aluminum Base Alloy Die Castings, alloy number as required.

12. Sand castings:

- (a) B 26 —Aluminum Base Alloy Sand Castings, alloy number and treatment as required.

Action Recommended

Acceptance for submission to letter ballot superseding subject-matter in the Manual.

Subject-matter to be Superseded

Specifications for Various Types of Non-Ferrous Metals and Alloys,
Manual Part 220.

RUST PREVENTIVES

Supplementing report presented at the 1948 Annual Meeting* on rust preventives with their recommended use, the following products are submitted as additional information:

Insul-Mastic is a protective coating claimed to have the properties of resisting weathering, rust and the effects of acid. In addition, this coating provides an insulation which has proven very effective against condensation. The product may be applied by spraying, brushing or troweling. The coating will not dry hard but will remain tough and flexible at all temperatures. The product will not check, crack, run or melt and will retain the bond, not becoming abraded or removed by impact or wear.

No Drip is a protective coating for application to metals to prevent rust or corrosion. The claim is made that surfaces treated with the product will not be affected by the action of acids, alkali, salt solutions, or vapors. The product is suitable for application by spraying, brushing or troweling and it must be protected while drying against oils, grease, petroleum and naphtha solvents as they soften the coating. A coat of paint over the product will effectively protect same.

Cordex is reported as having excellent properties for removing rust from ferrous metal and oxidation from brass, bronze, copper, chrome and nickel plate as well as steel, galvanized and zinc surfaces. The product makes an excellent bond for painting. It will also loosen studs, bolts and nuts frozen with rust. The product can be applied by spraying, dipping or wiping.

Penetrol is claimed to be a blend of heat-treated oils having a flash point above 150 degrees Fahrenheit. The oil when applied soaks up the rust, resulting in providing a coating beneath the rust or on the metal surface hardening into an elastic film which bonds to the metal. When hardening, a surface tack is retained to which paints adhere readily. The oil gives off no toxic fumes, which makes it suitable for use in confined spaces.

Roskote is formulated from a native pyro-bituminous ore and is claimed to be characterized by its infusibility, extreme toughness, high tensile strength, insolubility in water, resistance to temperature changes and the action of strong chemicals. The manufacturer claims that the product is highly resistant to corrosive environments and possesses the dielectric strength and resistivity to insulate effectively a metal surface, also that the coatings will adhere to metal and rubber and remain unaffected by light, rain, snow, relative humidity, dust, atmospheric pollution, and temperature fluctuations. The coating may be supplied black or pigmented in accordance with specification requirements for applications by dip, spray, brush, trowel or squeegee, with air-drying periods from 5 minutes to several hours. It is used today on air-brake equipment, switch controller rods, locomotive undercarriages, parts and equipment in storage and transit.

The Committee, in addition to investigating and reporting on products manufactured for the purpose of rust prevention, are analyzing the products

* A.A.R. Signal Section 1947 Proceedings, Vol. XLV, p. 262.

now commercially available with the idea in mind of submitting recommendations regarding the use of the various products for specific purposes.

The claims for the products shown above and those previously reported are those of the manufacturer.

Attention is called to the fact that the products listed must not be used for the purpose of removing rust from rails where difficulty might be expected with the sensitivity of track circuit shunt.

Action Recommended

Acceptance as information.

USE OF STAINLESS STEEL GUY AND MESSENGER STRAND

Supplementing report presented at the 1948 Annual Meeting*, further investigation develops that the amount of strand purchased and placed in service to date by the various railroads is as follows:

Amount purchased, ft.	Amount in service, ft.	Size, in.
52,800	52,800	$\frac{1}{4}$
5,500	—	$\frac{3}{32}$
3,600	3,600	$\frac{5}{16}$
3,500	1,250	$\frac{3}{8}$

As the installation of this strand is of such recent date, no definite opinion can be arrived at as to expected life. The installations will be followed and further report made as to service rendered by same.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION ELECTRICAL INSULATING MATERIALS IN GENERAL— PROJECT C59†

E. B. Smith, Representative
J. I. Kirsch, Alternate

At meeting of the Sectional Committee on November 18, 1948, the Secretary reported that on June 9, 1948 the A.S.A. approved as American Standard the revised A.S.T.M. Tentative Methods of Test for Impact Resistance of Plastics and Electrical Insulating Materials (D 256-47T; C 59.11-1948).

* A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 263 and 422.

† Previous report on Project C59 appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 263 and 422.

Also, the Committee was advised that with the recent organization of Sectional Committee J6 on Rubber Protective Equipment for Electrical Workers, it would seem the new Committee should have jurisdiction over the following standards formerly under the jurisdiction of Committee C59 so far as their A.S.A. status is concerned:

Specification for Electrical Gloves (Voltage Rating of Gloves 3,000 Volts) (A.S.T.M. D 120-40; A.S.A. C 59.12-1942), and

Specification for Rubber Matting for Use Around Electric Apparatus (Voltage Rating of Matting 3,000 Volts). (A.S.T.M. D 178-24; A.S.A. C 59.4-1935).

During the discussion on the desirability of continuing Sectional Committee C59, the Chairman pointed out it was originally planned that apart from the review of existing standards for reference to the A.S.A., the Sectional Committee would serve as advisory to other committees with respect to needed standardization in the electrical insulation field. In fact, the Committee did function to a somewhat limited extent in this direction. There had been some thought that a useful function would be served in maintaining an index of all available standards in the electrical insulating field, but at the last meeting of the Sectional Committee action was taken to discontinue such an index since it was felt that the Directory of Commodity Specifications served this purpose. At the present time the activities of the Sectional Committee are confined to the review of standards for reference to the A.S.A., and there had been some thought that this could be carried out in some other way.

The Secretary presented comments which had been received from several members who were unable to attend the meeting. Mr. F. S. Mapes advised that N.E.M.A. would wish to see the Sectional Committee continued, and while Mr. W. H. Gardner is no longer a member of the Sectional Committee, he felt that the Sectional Committee served an important purpose as a clearing house and if for no other reason than this it should be continued. On the other hand, Mr. R. W. Atkinson, representing the American Institute of Electrical Engineers, felt that the necessary activities of C59 could be handled effectively otherwise, and Mr. W. R. Fuller, representing A.S.T.M., felt that the continuance of the Sectional Committee is not vital so far as the A.S.T.M. Committee on Paint is concerned.

Each member present was then called upon to present his views in the matter, and while there was some divided opinion at first, it was later agreed that the Sectional Committee should be continued in view of its function as a clearing house. On motion by Mr. Smith, seconded by Mr. Anderson, it was voted to continue Sectional Committee C59.

Action Recommended

Acceptance as information.

COMMITTEE VIII—HIGHWAY GRADE CROSSING PROTECTION

Personnel

W. H. Stilwell, Chairman

....., Vice-Chairman

H. A. Appleby	H. C. Sampson
R. B. Elsworth	E. J. Seybold
H. T. Fleisher	W. R. Smylie
H. C. Griffith	J. G. Stonehouse
S. B. Higginbottom	C. H. Tillett
S. W. Law	E. P. Weatherby
H. G. Morgan	L. S. Werthmuller
E. N. Pearson	A. W. Wilson
W. F. Price	H. D. Blake*

H. A. Franklin*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on any development on highway grade crossing protection.
4. Investigate and report on the need for corrective measures to minimize phantom indications of flashing light signals, outlining conditions under which they occur.
5. Illumination of crossings.
6. Investigate and report on the use of diffusing lenses in electric light units for highway crossing signals to provide a wider range of indication where a long view is not required.
7. Prepare typical location plans for highway grade crossing protection devices.
8. Requisites for equal timing of operation of automatic highway crossing protection devices, based on trains moving at uniform or predetermined speeds throughout the approach to the crossing.
9. Investigate and report on the durability and methods of maintenance of reflectorized signs.
10. Investigate and report on methods for focusing and aligning railroad highway grade crossing flashing light signals in the field.
11. Instructions for focusing and aligning railroad highway grade crossing flashing light signals in the field.
12. System control requisites for automatic highway grade crossing protective devices.

* Consulting Member.

13. Investigate and report on the use of reflecting materials for backgrounds on signs covered by Drawings 1491, 1642, 1643, 1645, 1646, 1648, 1691, 1692 and 1693, collaborating with A.R.E.A. Committee 9.

The Committee submits for consideration, reports on the following subjects*:

3. Development on highway grade crossing protection.
9. Signs Used in Connection with Manually Protected Railroad Highway Grade Crossings, and Advance Warning Signs.
10. Methods for focusing and aligning railroad highway grade crossing flashing light signals in the field.
11. Instructions for Focusing and Aligning Railroad Highway Grade Crossing Flashing Light Signal Units, Reflector Type, with Sealed Lamp Receptacle.
13. Use of reflecting materials for backgrounds on signs.

Explanatory

As of interest to the Section, and for the reason that it is felt a reference sheet in the Signal Section Manual would be helpful, the Committee submits "Signs Used in Connection with Manually Protected Railroad Highway Grade Crossings, and Advance Warning Signs." This reference sheet covers signs other than signs on signals which are the prerogative of the Signal Section, found in the Manual of the American Railway Engineering Association. These signs are also found in Bulletin 3 issued by the A.A.R. Joint Committee on Grade Crossing Protection, as Figs. 25, 26, 27, 28 and 30.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.R.E.A.—American Railway Engineering Association, 59 E. Van Buren St., Chicago 5, Ill.

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.

Disposition of 1948 Letter Ballot Subject

The following subject presented by this Committee at the 1948 Annual Meeting was submitted to letter ballot and officially approved:

Requisites for Highway Grade Crossing Signals—Now in Manual Part 148.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

METHODS FOR FOCUSING AND ALIGNING RAILROAD
HIGHWAY GRADE CROSSING FLASHING LIGHT
SIGNALS IN THE FIELD

Since the report made at the 1947 Annual Meeting*, one other method of alignment has been reported in which front light units are aligned to the center of the approach lane 300 feet from the signal with the back light units aligned to the center of the approach lane directly adjacent to the front light signal location.

After having studied the methods reported to date, and after considerable field work to determine a desirable uniform and practical arrangement, the following method of aligning flashing light signals in the field, where two men are available, is recommended:

Straight mast signals.

This method, based on reflector type units, Specification 190, Manual Part 166, equipped with 30-degree spreadlight 15-degree downward deflection roundels in front and back light units, is for use where straight mast signals are installed on approximately level tangent highway and where two men are available. Alignment is obtained with the adjustment of one unit at a time by continuously lighting lamp and opening door wide so that clear light is displayed. Roundel and reflector should be inspected for cleanliness and installation to provide proper beam spread. One man is stationed at the signal unit, to make the necessary adjustments while the second man is at the alignment point to observe and direct the proper adjustments. The alignment point for front lights is the center of the approach lane 400 feet in approach to the front light signal location (see note 1), and for back lights is the center of the approach lane 50 feet in approach to the front light signal location (see note 2). The man at the alignment point, when observing the clear light, should obtain the full reflected beam, which in the case of the front lights at 400 feet is about 6 feet in diameter allowing some tolerance in the adjustments. After adjusting for vertical alignment, at 5 feet 6 inches (eye level) above the pavement (see note 3), adjust for horizontal alignment. Dark glasses are an asset for this work. Clamps are then tightened, the door closed, and after same procedure has been performed for the other units a check is made for adequate visibility with the lights flashing at 400 feet and as nearly as practicable at 1,500 feet for the front light signals, and at 400 feet for the back light signals.

For highways 40 feet wide and wider, the use of 70-degree spreadlight roundels in the back light units is recommended.

For crossings in direct line with the sun rising or setting, consideration should be given to the use of a device to minimize the effect of phantom indications. Where such device is considered, it must be recognized that such use reduces the spread and cuts down on the efficiency of the light to the extent that higher than the specified wattage lamps may be desirable.

With this method, adequate visibility to meet Requisite 10 of Requisites for Highway Grade Crossing Signals, Manual Part 148, is obtained at 1,500 feet in

* A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 260-A and 407-A.

approach to the crossing unless sharp curves or obstructions in the approach interferes. These conditions must be treated as special cases, keeping in mind that adequate visibility at 1,500 feet should be obtained if possible but that excellent visibility at 400 feet is essential. For these curve or obstruction conditions improved results may be obtained by the use of 70-degree spreadlight roundels in front light units.

Note 1: The center of the approach lane at 400 feet is determined as the alignment point for the following reasons:

(a) 400 feet is approximately twice the stopping distance for an automobile traveling at 50 miles per hour.

(b) The alignment point is in close proximity to the crossing so that two men working together can call or signal to each other for instructions.

(c) The clear light adjustment at 400 feet allows a distinct red flashing indication at 1,500 feet in approach to the crossing if the physical characteristics along the highway will permit.

(d) More universal use can be made of a method specifying the shorter distances.

Note 2: The axis of the back light beams is aligned to a point 50 feet in approach to the front light signal location and for the center of the approach lane to obtain a good close indication, it being recognized that the close up front light indication is not satisfactory when such units are aligned for a longer range.

Note 3: The vertical alignment is determined at 5 feet 6 inches above the pavement at the horizontal alignment points to obtain the best indication at these critical points as well as to prescribe a simple means of getting this adjustment from points already established. Tests have indicated that the 15-degree downward deflection provides for a good indication to the crossing with this alignment while the tolerance above the axis of the clear light beam causes the red signal to be adequate for the vision of drivers in big motor trucks and busses.

Action Recommended.

Acceptance as information.

A.A.R. SIGNAL SECTION INSTRUCTIONS.

FOCUSING AND ALIGNING RAILROAD HIGHWAY GRADE
CROSSING FLASHING LIGHT SIGNAL UNITS, REFLECTOR
TYPE, WITH SEALED LAMP RECEPTACLE

1949

Focusing.

1. Focusing of units must be made in factory or shop where facilities for providing adjustments are available.

Aligning.

2. Method of aligning units equipped with 30-degree spreadlight 15-degree downward deflection roundels in front and back lights, on straight mast signals, where two men are available, is illustrated in Fig. 1, and procedure is as follows:

(a) Procedure for front lights.

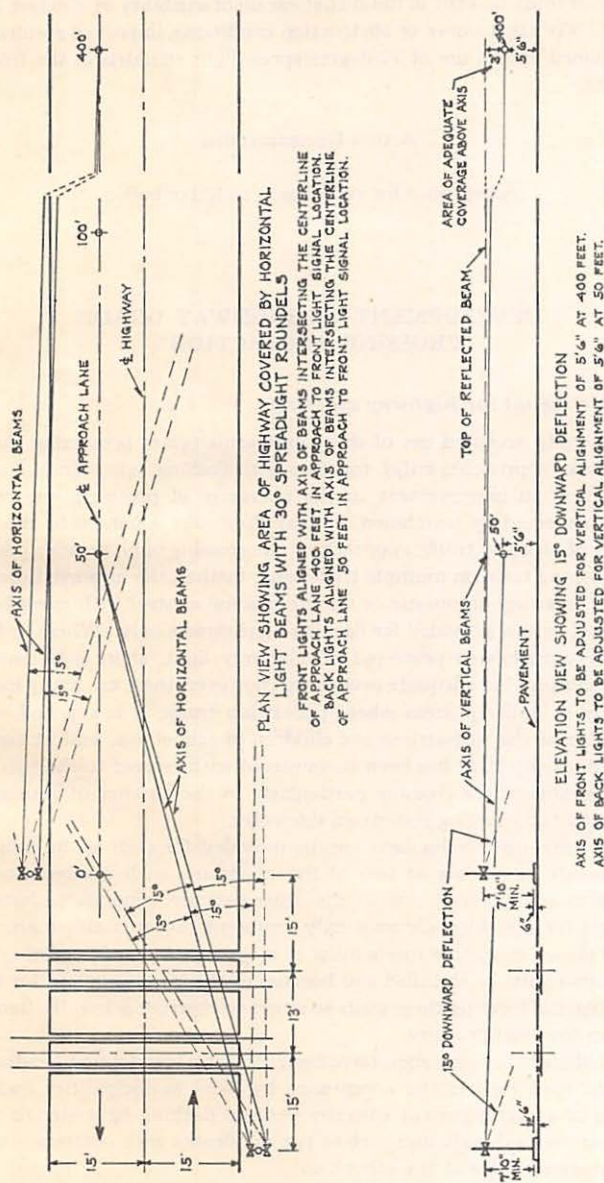
1. Continuously light one lamp.
2. Open door wide so clear light is displayed.
3. Align light unit vertically to 5 feet 6 inches above pavement at 400 feet with clear reflected beam.
4. Align light unit horizontally to center of approach lane at 400 feet with clear reflected beam.
5. Tighten clamps and close door.
6. Repeat instructions 2-a-1 to 2-a-5, inclusive, on other front light units.
7. Check for adequate visibility at 400 feet and as nearly as practicable at 1,500 feet with lights flashing.

(b) Procedure for back lights.

1. Continuously light one lamp.
2. Open door wide so clear light is displayed.
3. Align light unit vertically to 5 feet 6 inches above pavement at 50 feet with clear reflected beam.
4. Align light unit horizontally to center of approach lane at 50 feet in approach to front light signal location with clear reflected beam.
5. Tighten clamps and close door.
6. Repeat instructions 2-b-1 to 2-b-5, inclusive, on other back light units.
7. Check for adequate visibility at 400 feet with lights flashing.

(c) For highways 40 feet wide and wider, the use of 70-degree spreadlight roundels in the back lights provides a more desirable close indication.

(d) Wherever a device to minimize the effect of phantom indications is required, the spread is reduced and the efficiency of the light cut down to the extent that higher than normal wattage lamps may be desirable to improve the indication.



Aligning.—Continued.

- (e) It is important to obtain adequate visibility at 1,500 feet if possible, but where sharp curves or obstructions in the approach interfere, it must be kept in mind that excellent visibility at 400 feet is essential. For these curve or obstruction conditions, improved results may be obtained by the use of 70-degree spreadlight roundels in the front light units.

Action Recommended

Acceptance for submission to letter ballot.

DEVELOPMENT ON HIGHWAY GRADE
CROSSING PROTECTION**Pedestrian signal for highway crossings.*

The generally accepted use of short gate arms (gates protecting the right-hand highway approaches only), together with flashing light signals and signs, has permitted an improvement in the character of protection at crossings presently protected by watchmen, in that they offer a barrier to the normal movement of highway traffic approaching the crossing only, provide protection against a second train on multiple track, and, further, the improved protection lends itself to either automatic or remote manual control with essentially the same control as now provided for flashing light signals only. Where pedestrian traffic over crossings so protected is relatively light, short gate arms with flasher signals provide adequate protection; however, there are many localities, particularly in built-up areas where pedestrian traffic is heavy and where a large number of the pedestrians are children of school age, and at certain of these locations objection has been encountered with respect to the two unprotected quadrants of the crossing particularly to the absence of gate arms on those quadrants protecting pedestrian sidewalks.

Whereas gate arm mechanisms can be provided for each of the four quadrants, sidewalk arms only at two of the quadrants with combination short roadway arm and sidewalk arm at the other two, the separate pedestals and mechanisms for the sidewalk arms only represent objectionable maintenance items in that an expensive mechanism of a type capable of operating longer roadway arms must be installed and because of the space required for mounting, the matter of locating these posts so as not to obstruct sidewalks frequently becomes an involved problem.

Vertical illuminated stop signs have been used at a few isolated locations and one eastern road reports the acceptance by local municipalities and State authorities of an arrangement whereby vertical flashing light signals will be installed between sidewalk and curb at two quadrants with combination roadway and sidewalk arms at the other two.

* Previous report on this subject appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 267 and 411.

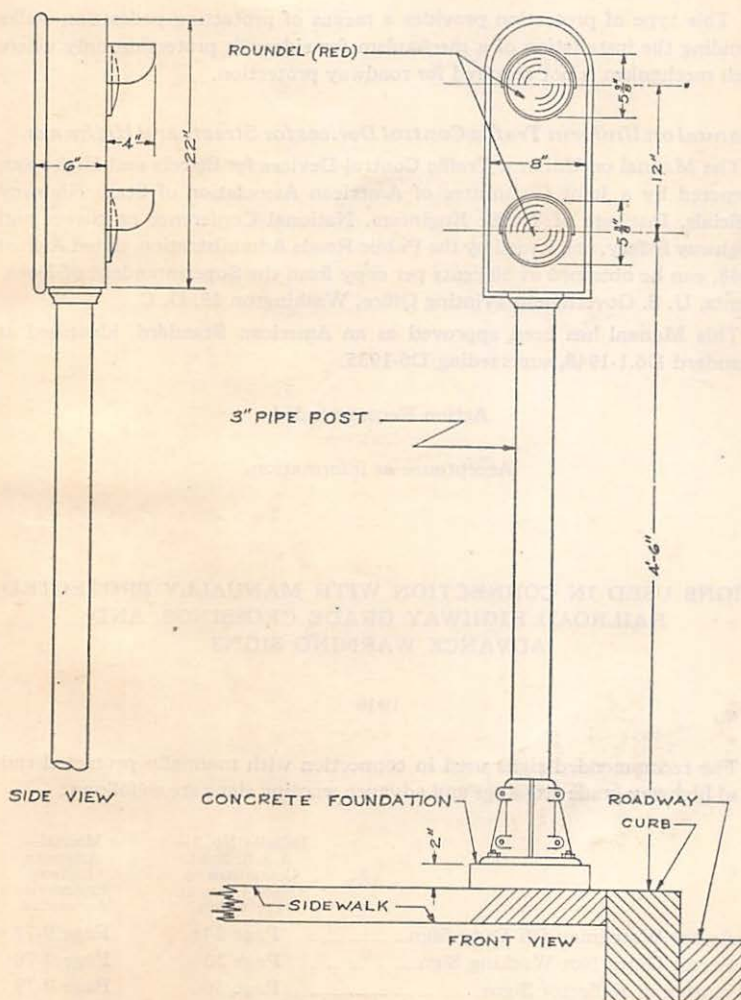


FIG. 1

The pedestrian flashing light signal designed for this particular application, shown in Fig. 1, is mounted on a 3-inch pipe post with a cast-iron housing enclosing two 5 $\frac{3}{8}$ inch diameter red flashing light signals, arranged in a vertical plane 12 inches from center to center with the center of the lower unit 4 feet 6 inches above the elevation of sidewalk. Signals are mounted between curb and sidewalk proper.

This type of protection provides a means of protecting pedestrian walks avoiding the installation of a mechanism for sidewalk protection only where such mechanism is not required for roadway protection.

Manual on Uniform Traffic Control Devices for Streets and Highways.

The Manual on Uniform Traffic Control Devices for Streets and Highways, prepared by a Joint Committee of American Association of State Highway Officials, Institute of Traffic Engineers, National Conference on Street and Highway Safety, and issued by the Public Roads Administration, dated August 1948, can be obtained at 50 cents per copy from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

This Manual has been approved as an American Standard, identified as Standard D6.1-1948, superseding D6-1935.

Action Recommended

Acceptance as information.

SIGNS USED IN CONNECTION WITH MANUALLY PROTECTED
RAILROAD HIGHWAY GRADE CROSSINGS, AND
ADVANCE WARNING SIGNS

1949

The recommended signs used in connection with manually protected railroad highway grade crossings and advance warning signs are as follows:

	Bulletin No. 3— A.A.R. Joint Committee on Grade Crossing Protection	Manual— American Railway Engineering Association
Reflector Watchman Off Duty Sign.....	Page 34	Page 9-77
Reflector Gates Not Working Sign.....	Page 35	Page 9-78
Mounting of Reflector Signs.....	Page 36	Page 9-79
Cover Plates for Signs.....	Page 37	Page 9-80
Advance Warning Sign.....	Page 39	Page 9-17

Action Recommended

Acceptance for submission to letter ballot.

USE OF REFLECTING MATERIALS FOR BACKGROUNDS ON SIGNS

In connection with assignment 13, questionnaire (Inquiry SS-86A) was issued to Voting Representatives of Member Roads in the Signal Section on February 16, 1949. Following is the information obtained from replies of 73 railroads:

Number of roads using reflecting materials for this purpose.....	16
Number of roads reporting over 100 signs in service.....	2
Total number of signs reported in service.....	935

A number of the roads reporting a small number of signs of this type in service indicated that they were installed for test purposes. One road reported they propose to change all their highway crossing signs to signs of this type during the current year.

Action Recommended

Acceptance as information.

COMMITTEE IX—OVERHEAD AND UNDERGROUND LINES

Personnel

G. C. Felton, Chairman	
W. W. Beard, Vice-Chairman	
F. W. Bender	V. O. Smeltzer
H. H. Cooper	R. C. Steele
M. A. Nyberg	E. P. Stephenson
R. H. Smedley	W. M. Vogts
E. Winans	

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Investigate and report on use of insulation for wire and cable other than materials covered by specifications now in the Manual.
4. Investigate and report on the use of self-supported aerial cables and the use of spinning wire in connection with cables, including cables having plastic jackets.
5. Investigate and report on the various types of coverings for line wires now available.
6. Investigate and report on improved methods of splicing signal line wires, and making terminal and branch connections.
7. Performance specification for solderless type connectors for making line connections (various size conductors).

The Committee submits for consideration, reports on the following subjects*:

3. Stainless steel armor for submarine cable.
4. Use of self-supported aerial cables and the use of spinning wire in connection with cables, including cables having plastic jackets.
5. Various types of coverings for line wires.

Cooperative report. American Society for Testing Materials, Subcommittee IX—Insulating Tapes (Committee D-11—Rubber Insulating Materials).

Cooperative report. American Standards Association—Insulated Wires and Cables (Other than Telegraph and Telephone)—Project C8.

Information

Specifications, etc. of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.
A.S.T.M.—American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

Disposition of 1948 Letter Ballot Subjects

The following subjects presented by this Committee at the 1948 Annual Meeting were submitted to letter ballot and officially approved:

- Specification 145-48—Single and Multiple-Conductor, Insulated, Lead-Covered Parkway Cable, Armored with Flat Steel or Zinc Tape—Now in Manual Part 20.
- Specification 89-48—Multiple-Conductor Insulated Cable with Weather-Resistant or Flame-Retarding Moisture-Resistant Braid Covering—Now in Manual Part 25.
- Specification 90-48—Multiple-Conductor Insulated Submarine Cable, Lead Sheathed and Round Steel Armored—Now in Manual Part 26.
- Specification 91-48—Single and Multiple-Conductor Insulated Lead Sheathed Cable—Now in Manual Part 28.
- Specification 161-48—Single and Multiple-Conductor, Insulated, Non-Metallic Sheathed Cable—Now in Manual Part 36.
- Specification 168-48—Copper Alloy Wire with or without Weather-Resistant Covering—Now in Manual Part 173.
- Specification 167-48—Copper-Covered Steel Wire with or without Weather-Resistant Coverings—Now in Manual Part 180.
- Specification 196-48—Copper-Bearing Steel Wire with or without Weather-Resistant Covering—Now in Manual Part 181.
- Specification 169-48—Hard-Drawn Copper Wire with or without Weather-Resistant Covering—Now in Manual Part 182.
- Specification 111-48—Single-Conductor Insulated Wire and Cable with Flame-Retarding, Moisture-Resistant or Weather-Resistant Braid Covering or Outer Polychloroprene Sheath—Now in Manual Part 186.
- Specification 239-48—Polychloroprene Compound Sheath for Insulated Wire and Cable—Now in Manual Part 248.
- Specification 240-48—Single and Multiple-Conductor, Insulated, Polychloroprene Compound Sheathed Cable—Now in Manual Part 249.
- Specification for Steel Pipe Conduit—Now in Manual Part 29.
- Specification for Wrought Iron Pipe Conduit—Now in Manual Part 40.

PROGRESS REPORT

STAINLESS STEEL ARMOR FOR SUBMARINE CABLE

In presenting Specification 90-48, Manual Part 26, at the 1948 Annual Meeting, the Committee was questioned as to whether or not they had considered the use of stainless steel armor for submarine cable. As they had not, a study was made of the use of this material with the following result:

Two important factors would have to be considered in the use of stainless steel:

1. Resistance to corrosion.

Corrosion prediction cannot be made with high accuracy because of the impossibility of evaluating all the factors, and becomes largely a matter of judgment based on experience and requirements.

Stainless steel is widely used where contact is made with sea water at high velocity, e.g., pump impellers, etc., and gives excellent service. However, when exposed to quiet or slowly moving sea water, especially where marine organisms may become attached, pitting may be induced.

Examination of two submarine cables having armor of galvanized mild steel wires directly over a layer of jute was made to determine the effect of corrosion. One of the cables was installed at New York City in 1907 in sea water, and in the year 1931 a similar cable was installed adjacent to it. The armor of both was found to be in good condition in the area exposed at low tide. However, the jute directly under the armor on the older cable had practically disappeared.

2. Cost.

It is believed that no such armor has been used to date. However, approximate costs of various armoring materials may be used to effect a comparison and the following table is based on providing an armor for a cable of 19 conductor, No. 14 solid, $\frac{5}{64}$ inch insulation, tape over assembly, $\frac{5}{64}$ inch lead sheath, $\frac{5}{64}$ inch jute bedding, B.W.G. armor wire. This cable is in accordance with Signal Section Specifications and the armor in accordance with Specification 90-48, Manual Part 26.

Material	Lbs. required to armor 1,000 feet of cable	10-ton lot cost in dollars per lb.	Cost in dollars to armor 1,000 feet of cable
Galvanized steel.....	2,150	0.07	\$ 150.00
Stainless steel:			
Alloy No. 302.....	2,175	0.50	1,000.00
Alloy No. 316*.....	2,175	0.70	1,400.00
Monel:			
Copper nickel alloy—nickel			
30 per cent.....	2,450	0.60	1,500.00
Hard-drawn copper.....	2,450	0.25	600.00

* Alloy No. 316 is recommended for salt and brackish water.

It would seem likely that to improve upon the cable construction would be of definite value and this might be accomplished by the use of a neoprene jacket to replace the jute. By providing an extra outer protection at the shore ends, especially in tidal areas, to prevent abrasion of the armor due to cable movement, would undoubtedly insure longer life. This extra outer protection would be added at the shore ends after the cable had been positioned.

Action Recommended

Acceptance as information.

USE OF SELF-SUPPORTED AERIAL CABLES AND THE USE OF SPINNING WIRE IN CONNECTION WITH CABLES, INCLUDING CABLES HAVING PLASTIC JACKETS

While there have been a few installations of self-supported aerial cable for signaling purposes, this type of construction for the most part has been concentrated in the utility field where tree conditions make the operation of open-wire primary feeders a troublesome problem.

Among some of the advantages claimed for this type of construction are:

1. Reasonable cost.
2. Good appearance.
3. No messenger rings required.
4. Eliminates "bowing" and ring cutting.
5. Simple to install.
6. Lightweight.
7. Eliminates the necessity for grade clamps.

The same advantages are claimed for the use of spinning wire, but this type of construction also, while used extensively for communication purposes, has had limited application in the field of signaling.

Action Recommended

Acceptance as information.

VARIOUS TYPES OF COVERINGS FOR LINE WIRES*

In addition to the weather-resistant coverings provided for by current American Standard C8.18, the following coverings are also available:

1. Vinyl Acetal resin varnish with Polyvinyl-Chloride covering.
2. Polyethylene.
3. Polychloroprene.

Considerable quantities of line wire with the Vinyl Acetal varnish and Polyethylene coverings have been furnished for signaling purposes. However, an attempt will be made to assemble more precise information concerning the performance of synthetic coverings and report made at the 1950 Annual Meeting.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 325 and 404.

COOPERATIVE REPORT

AMERICAN SOCIETY FOR TESTING MATERIALS
SUBCOMMITTEE IX—INSULATING TAPES (COMMITTEE D-11—
RUBBER INSULATING MATERIALS)*

J. J. Corcoran, Representative

Chairman R. H. Titley has reported that no additional action has been taken by Subcommittee IX since the March meeting. The vote on the recommendations with respect to the tape specifications, as presented in the annual report, had been favorable. The Subcommittee is now working on sampling clauses.

The annual report of Committee D-11 was favorably voted upon with the exception of the revision of the Specification for Insulated Wire and Cable, Class AO, 30 Per Cent Rubber Compound D27-46T. In this case there were a number of negative votes cast, including the vote of the Signal Section's representative, and because of the objections the Subcommittee had decided to withhold recommendation. The principal objection to the revised specifications was the inadvisable and unnecessary reduction of the insulation resistance requirement.

Action Recommended

Acceptance as information.

COOPERATIVE REPORT

AMERICAN STANDARDS ASSOCIATION
INSULATED WIRES AND CABLES (OTHER THAN TELEGRAPH
AND TELEPHONE)—PROJECT C8

J. J. Corcoran, Representative

Technical Committee No. 12—Weather-Resistant Wire has completed its current assignment with the issuance of the Specifications for Weather-Resistant (Weatherproof) Wire and Cable (URC Type) (Revision of C8.18-1942), C8.18-1948. Chairman C. T. Sinclair expects to arrange for a meeting for discussion of new developments in weather-resistant coverings.

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1945 Proceedings, Vol. XLIII, pp. 244 and 386.

COMMITTEE X—SIGNALING PRACTICE

Personnel

J. J. Corcoran, Chairman	
G. K. Thomas, Vice-Chairman	
E. N. Fox	S. E. Noble
W. N. Hartman	H. L. Stanton
S. W. Law	C. R. Swenson
H. G. Morgan	C. H. Tillett
L. C. Walters	

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Revision of Manual.
2. Indexing signal literature.
3. Report on noteworthy changes in signal practices.
4. Recommend uniform signal practice in the use of aspects and indications for railway signaling.
5. Recommend methods of controlling signals in single-track automatic block signal territory.
6. Investigate and report on new signal devices and related appliances.
7. Investigate and report on the utility of highway vehicles in lieu of rail motor cars for railway signal work.
8. Investigate and report on the economy of approach lighting of signals.

The Committee submits for consideration, reports on the following subjects*:

3. Noteworthy changes in signal practices.
5. Methods of controlling signals in single-track automatic block signal territory.
6. New and improved devices and related appliances.
7. Types of highway vehicles recommended for railway signal work in lieu of rail motor cars.
8. Use of, and methods of, approach lighting signals on single and multiple track.

Disposition of 1948 Letter Ballot Subjects

The following subjects presented by this Committee at the 1948 Annual Meeting were submitted to letter ballot and officially approved:

Signaling for Gravity Classification Yards—Now in Manual Part 42.
Requisites for Automatic Block Signaling Systems—Now in Manual Part 87.
Requisites for Interlocking—Now in Manual Part 94.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

NOTEWORTHY CHANGES IN SIGNAL PRACTICES*

Automatic switching.

A system for the automatic operation of switches in a classification yard has been developed. Essentially, it consists of routing a car, or cut of cars, from the hump to any classification track desired—merely by the act of pressing a button identified with that particular track.

A panel at the crest of the hump contains a pushbutton for each track. Before a car is uncoupled, one of the buttons is pressed to establish the route for the car to the designated track. The designation is recorded by the system and serves to position the switches ahead of the car, as it travels along. Several routes may be established in succession and each route will take effect, in progression, as the preceding car clears each switch.

Since automatic switching relieves the retarder operator of the task of lining switches, his only duty is operating the retarders to control the speed of the cars and maintain proper spacing between them. He is, therefore, able to handle more cars, and it may be possible that retardation control can be concentrated in a fewer number of towers.

To place control of all yard functions within reach of the one operator, a new type control machine has been developed. The operator can cancel routes set up by automatic switching or, if desired, he can operate the switches from the panel. Smaller levers, for controlling the retarders and switches, are utilized on the machine and are placed in the same relation to each other as the functions are located geographically.

While the new type control machine was developed in conjunction with automatic switching, it has very definite advantages in small yards where automatic switching may not be needed, since it provides for more rapid and accurate manual control of switches.

Action Recommended

Acceptance as information.

TYPES OF HIGHWAY VEHICLES RECOMMENDED FOR
RAILWAY SIGNAL WORK IN LIEU OF
RAIL MOTOR CARS†

The following recommendations were obtained from replies to a questionnaire (Inquiry SS-83A) which was issued December 30, 1948 to Voting Representatives of Member Roads in the Signal Section:

Seventy replies were received, 21 of which made no recommendations because of lack of experience.

* Previous report on this subject appears in A.A.R. Signal Section 1946 Proceedings, Vol. XLIV, pp. 277-A and 411-A.

† Previous report on this subject appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 333 and 397.

1. Recommended type, size, body, etc. of vehicle for signal maintainer.

Forty-seven recommendations were received. Of these there were 29 recommendations for $\frac{1}{2}$ ton trucks; 1 for a sedan delivery car; 2 for jeeps; 8 for $\frac{3}{4}$ ton trucks; 4 for 1 ton trucks; and 3 for $1\frac{1}{2}$ ton trucks.

Twenty-one recommended trucks of the pick-up type. Of these there were 13 recommendations for specially fitted trucks to carry tools and supplies.

The recommendations are shown below in more detail:

No. of recommendations	Description of highway vehicles recommended for signal maintainer
9	$\frac{1}{2}$ ton pick-up truck.
2	$\frac{1}{2}$ ton pick-up truck with canvas cover for truck bed.
1	$\frac{1}{2}$ ton pick-up truck with additional seat.
1	$\frac{1}{2}$ ton truck with enclosed cab and open pick-up body.
1	$\frac{1}{2}$ ton pick-up truck equipped with two Model 4804 utility compartments.
1	$\frac{1}{2}$ ton pick-up truck—specially fitted for tools and material compartment mounted on bed of truck.
1	$\frac{1}{2}$ ton pick-up with heater.
9	$\frac{1}{2}$ ton truck panel body.
1	$\frac{1}{2}$ ton truck panel body equipped to carry necessary tools and supplies.
1	$\frac{1}{2}$ ton truck with body similar to that used on Bell Telephone maintenance truck.
1	$\frac{1}{2}$ ton chassis equipped with 72-inch maintenance and installation body.
1	$\frac{1}{2}$ ton truck—116-inch wheel base—4 speed transmission similar to G.M.C. Model TC-101.
1	Sedan delivery car with overload rear springs—can be equipped with racks and shelves.
1	Jeep.
1	Jeep—4 wheel drive—aluminum body—with heater.
2	$\frac{3}{4}$ ton pick-up truck.
2	$\frac{3}{4}$ ton pick-up with body similar to that used on Bell Telephone maintenance trucks.
1	$\frac{3}{4}$ ton truck—panel body with additional seat.
1	$\frac{3}{4}$ ton chassis Model B7 Graybar body with ladder racks.
1	$\frac{3}{4}$ ton truck—Body Powers Series 35 M General Service.
1	$\frac{3}{4}$ ton IHC Dodge or Chevrolet Express—125-inch wheel base—cab—open bed or American Coach Co. maintenance bed. 7:00x15 tires.
1	1 ton truck—panel body with additional seat.
2	1 ton pick-up with tool boxes 9 feet long and 6 feet wide.
1	1 ton Dodge Model WD 20 McCable Powers Utility Body Model 35 M.
1	$1\frac{1}{2}$ ton pick-up with canvas cover.
1	$1\frac{1}{2}$ ton pick-up with special removable tool box to be placed back of cab.
1	$1\frac{1}{2}$ ton truck—panel body.

2. Recommended type, size, body, etc., of vehicle for small maintenance gang.

Thirty-three recommendations were received. Of these there were 11 recommendations for $\frac{1}{2}$ ton trucks; 2 for a station wagon; 8 for $\frac{3}{4}$ ton trucks; 6 for 1 ton trucks; 6 for $1\frac{1}{2}$ ton trucks; 11 recommended trucks of the pick-up type; 6 recommended stake bodies; 5 recommended panel bodies, and 13 recommended trucks specially equipped to carry tools, material and men.

The recommendations are shown below in more detail:

No. of recommendations	Description of highway vehicles recommended for small signal maintenance gang
6	$\frac{1}{2}$ ton pick-up truck.
1	$\frac{1}{2}$ ton truck equipped with seats for gang.
2	$\frac{1}{2}$ ton truck—enclosed cab—open box bed.
1	$\frac{1}{2}$ ton pick-up truck—specially fitted for tools and material compartments mounted on bed of truck. Provision made for men to ride protected by cover.
1	$\frac{1}{2}$ ton truck—panel body.
1	Station wagon with rear seat removed and space arranged for small material and tools.
1	Station wagon with trailer for tools and supplies.
2	$\frac{3}{4}$ ton pick-up truck.
1	$\frac{3}{4}$ ton pick-up truck with body similar to that used on Bell Telephone maintenance trucks.
1	$\frac{3}{4}$ ton truck—panel body.
1	$\frac{3}{4}$ ton truck—panel body with built-in bins and tool compartment which can be used as seats.
1	$\frac{3}{4}$ ton chassis equipped with 90-inch service body.
1	$\frac{3}{4}$ ton 130-inch chassis with standard steel panel type body modified to provide seating for employees and storage space for small tools.
1	1 ton pick-up truck.
4	1 ton truck—panel body.
1	1 ton panel body truck, 9 feet with 122-inch wheel base having loading space 108.5 inches long, 55.4 inches wide and 55 inches high; side seats built into this truck with material bins underneath, and small, shallow bins provided along the sides and back of the seats, for small materials.
2	$1\frac{1}{2}$ ton truck—stake body.
4	$1\frac{1}{2}$ ton truck—stake body—with winch and A-frame for handling poles.

3. Recommended type, size, body, etc., of vehicle for construction gang.

Forty-eight recommendations were received. Of these there were 1 recommendation for a suburban carry-all; 1 for a jeep; 1 for a truck with trailer suitable for handling poles, size dependent upon number of men to be handled, etc.; 29 for $1\frac{1}{2}$ ton trucks; 3 for $1\frac{1}{2}$ or 2 ton trucks; 3 for 2 ton trucks; 2 for 2 or 3 ton trucks; 4 for $2\frac{1}{2}$ ton trucks; 2 for 3 ton trucks; and 2 for a combination of 2 or more vehicles, one being for a $1\frac{1}{2}$ ton truck and a jeep, the other being for a $2\frac{1}{2}$ ton stake body truck and two $\frac{3}{4}$ ton panel body trucks.

The recommendations are shown below in more detail:

No. of recommendations	Description of highway vehicles for use of construction gang
1	Suburban carry-all.
1	Jeep, 4-wheel drive.
1	Truck with trailer suitable for handling poles. Size dependent on number of men to be handled and supplies and tools to be taken care of.
2	1½ ton open body truck.
4	1½ ton stake body truck.
2	1½ ton stake body truck with canvas cover.
4	1½ ton stake body truck with canvas cover and dual wheels.
1	1½ ton stake body truck with canvas cover and seats for carrying men.
4	1½ ton stake body truck with winch and A-frame for handling poles.
1	1½ ton stake body truck with small derrick or crane for pole line work.
1	1½ ton, high speed, heavy duty stake body truck equipped with 10,000 lb. capacity power winch and demountable steel A-frame.
1	1½ ton truck with wood or metal lined body with or without power take off, winch and derrick equipment.
1	1½ ton truck specially fitted with tool and material compartments. Provision made for men to ride protected from the weather.
3	1½ ton closed body truck.
1	1½ ton covered truck with wood sides about 3 feet high equipped with compound low and overdrive. For gangs consisting of 6 to 18 men.
1	1½ ton truck 12 feet long, 7 feet wide, and 6 feet high inside with standard steel panel type body modified to provide seating for employees. Bins provided under seats for storage of tools and materials.
1	1½ ton Ford truck, weight 6,300 lbs. Engine Model 87HT 1948. Army steel troop carrying body with folding seats for 16 or more men.
1	1½ ton IHC Dodge or Chevrolet Express, 161-inch wheel base with cab and stake body, one-half of bed covered, dual rear wheels.
1	1½ ton BHI Dodge with power body Model 500.
2	1½ or 2 ton truck with open box bed, enclosed cab and equipped with detachable A-frame for chain hoist.
1	1½ or 2 ton truck with 12 foot body. Tool compartment at front end and on sides for seats. Seats are removable if large items are trucked.
1	2 ton truck chassis equipped with 112-inch line construction body, sliding roof, 25,000 lbs. winch and pole derrick.
2	2 ton truck with special van body for carrying tools and material, also power winch and A-frame.

No. of recommendations

- 2 2½ ton truck for utility service, 13 feet long, 6 feet high, 5 feet wide inside; 7 feet wide outside, bin seats inside, outside tool compartments, panel construction, side ladder racks.
- 1 2 or 3 ton truck with staked body and canvas cover.
- 1 2 or 3 ton chassis with Model U-10 Graybar body, 7 man cab, complete with winch, derrick, take-up reel and Model 1435A pole trailer.
- 2 2½ ton truck with stake body and canvas.
- 1 3 ton truck with stake body and canvas cover.
- 1 3 ton covered truck with riding compartment behind driver's cab, material compartment in rear and built-in tool compartments on exterior side.

Combinations of 2 or more vehicles

- 1 { One 1½ ton truck with stake body.
One Jeep, 4-wheel drive.
- 1 { One 2½ ton truck with stake body, canvas cover and rear step.
Two ¾ ton panel body trucks.

Action Recommended

Acceptance as information.

USE OF, AND METHODS OF, APPROACH LIGHTING SIGNALS
ON SINGLE AND MULTIPLE TRACK

Information obtained as to the use of, and methods of approach lighting signals on single and multiple-track as obtained from replies to questionnaire (Inquiry SS-84A) issued December 30, 1948 to Voting Representatives of Member Roads in the Signal Section:

Replies were received from 66 railroads.

Forty-two roads reported approach lighting of signals in service as follows:

Single track.....	27,262 road miles
Two tracks.....	11,025 road miles
Three tracks.....	165 road miles
Four tracks or more.....	350 road miles

Thirteen roads reported that they do not use approach lighting of signals.

Eleven roads reported no signaling on their lines.

Of the roads reporting approach lighting of signals:

- 31 roads approach light head block signals; 11 do not.
- 23 roads approach light interlocking home signals; 19 do not.
- 14 roads approach light signal for the route only in multiple track; 19 roads approach light all signals at the location; 9 roads made no answer to the question.
- 17 roads light all signals at the same time for conflicting routes when train approaches; 18 do not; 7 roads made no answer to the question.

Fourteen roads reported that in their approach lighted territory the signal governing movements into a block remains lighted with the block occupied; 28 roads reported that the signal does not remain lighted with the block occupied.

Four roads reported that the approach signals remain lighted with the home block occupied; 38 roads report that they do not remain lighted.

Four roads reported having a standard approach distance for approach lighting of their signals; 38 roads vary the distance they approach light their signals depending on physical features of the territory, convenience of signal locations and speed of their trains.

Economies reported in connection with the use of approach lighting of signals and the number of roads reporting same are:

- 18 roads reported savings due to increased primary battery life.
- 24 roads reported savings due to increased lamp bulb life with subsequent savings in labor.
- 17 roads reported savings in commercial power usage.
- 10 roads made no report.

The opinions expressed as to the specific conditions under which there is an advantage in approach lighting of signals and the number of roads expressing same are given below:

- 7 roads thought it aided maintenance-of-way employees in determining when trains were approaching.
- 6 roads thought there was less chance of the engineman and fireman confusing signals where several signals could be seen.
- 3 roads thought there were advantages due to less lamp bulb failures and battery failures.

The opinion expressed as to the specific conditions under which there is an advantage in the continuous lighting of signals and the number of roads expressing same are given below:

- 23 roads thought continuous lighting provided more information and warning of approach of trains for maintenance of way employees.
- 5 roads thought that signals should be lighted so that signals can be seen as far away as possible.
- 8 roads thought continuous lighting aided in the detection of the failure of signal apparatus.

Action Recommended

Acceptance as information.

NEW AND IMPROVED DEVICES AND RELATED APPLIANCES*

Dynamometer for testing spring switches.

A device, obtainable from the Pettibone Mulliken Corp. has been developed to quickly measure the pressure exerted against the head rod by a spring switch mechanism, and also test the buffing action when the switch is restoring to its normal position. Two U-shaped hooks are fitted over the stock rail at the normally-open switch point, and a hydraulically operated plunger is made to push the open point toward the stock rail, thus pulling the normally closed point away from its position. Pressure to actuate the plunger is gradually built up and can be measured by a gage. Rapid releasing of the pressure, by opening a valve, allows the spring switch mechanism to work back against the buffer. This avoids former cumbersome methods of making this test by blocking the switch point and operating the stand against the spring pressure, and then knocking the block out.

The mechanism is light and readily portable, and also has the advantage of rapid placement and removal from track.

Applications of remote-controlled gas switch heaters.

The snow and ice of winter have usually presented a problem at remote locations where it is difficult to get snow-fighting forces on the job in time to avoid trouble with switches when a heavy snowfall develops rapidly. Gas switch heaters are now available provided with complete remote control which turns on the gas, ignites the heater and keeps it lit as long as desired, as well as indicating back to the control point that the heater is performing its duty. When no longer needed, the heater is readily turned off by the remote control system. One type of equipment developed by The Rails Co. comprises an automatic ignition unit of four to six automotive spark coils, one coil for each burner section. This unit may be sheltered in any convenient housing in the vicinity of the switch. A low-voltage direct current magnetic valve is provided to control the flow of gas from the supply line, and an electronic interval timer controls the rate of sparking at the spark plugs. Where a number of switch heaters are in service, such as at an interlocking, the electronic interval timer may be combined with a selector so that sparking takes place at each switch in turn, until all heaters have been sparked. The spark plugs in each heater section are so located that the spark gap is directly in the path of the gas as it leaves the inspirator.

Control from the central point may be through the centralized traffic control apparatus when in centralized traffic control territory, or by direct control circuits from a convenient nearby tower, station, dispatcher's office, etc.

Further developments in this field have been made by The White Manufacturing Co., and also The Rails Co., using hot wire units operated from the local power source and controlled by the same action of the control lever that operates the gas valve. A thermocouple, actuated by heat from the ignited heater unit, controls an electrical contact which indicates back to the con-

* Previous report on this subject appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 331 and 397.

trol point that the heater is in operation. If the heating unit gas flame should become extinguished, the thermocouple cools and closes a contact to operate the hot-wire unit and restore the cycle of operation.

When local supplies of gas are not available, the heaters may be provided with gas in cylinders or from bulk gas tanks, as governed by local requirements.

Improved switch circuit controller.

A new switch circuit controller, whose design provides highly sensitive detection of switch point position, has been brought out by the General Railway Signal Co. and designated as the Model 8. Improvements have been incorporated in the form of larger bearing surfaces and increased contact pressures.

In general appearance this controller is similar to the older Model 7. Internally, the terminal compartment is separated from the mechanism portion. Four direct-acting cams with hardened steel inserts in their contacting surfaces, strike the shoulders of the steel inserts in the rocker arms to operate the contact fingers, each cam being adjustable by a worm gear principle on the shaft. Two eccentric bushings in the walls of the case support the shaft so as to cause the cams to ride upon the extensions of the rocker arms. This avoids any movement of the contact, which might otherwise result from passage of trains, and cause wear. The contacts will not change position when the switch points move an eighth of an inch, but movement of one-quarter inch will open the normal contacts and close the reverse contacts.

Condensation, which might result in frosting or freezing on the contacts, is practically eliminated by two ventilating ports located on opposite sides of the case. Cam shaft bearings are lubricated through pressure fittings inside the case. The operating crank may be secured with an insulated or non-insulated ball stud, as required, and the stud is equipped with a pressure lubricating fitting.

Bootleg riser.

A new design of bootleg riser has been presented by the Ohio Brass Co. in an effort to provide a means of connection which is devoid of possible failure from breakage of bolted or soldered connections. A simple and effective design, employing the Hammerhead terminal and strand construction used in the signal bonds made by the same company, is used in an endeavor to overcome such failures. The bootleg riser assembly comprises a cast-iron riser which is topped by a bronze head in which are three holes, two of which are for the terminals of the regular Hammerhead bootleg bonds and the third hole is equipped with a special terminal which is drilled through the sleeve to accommodate the signal wire which is brought up through the riser and through a hole in the bronze head. Fibre insulation is provided between the riser and the bronze head. The signal wire is slipped through the special Hammerhead terminal and the terminal is then driven home into its hole. This operation "cold welds" the wire tight to the riser head. The terminals of the two Hammerhead bootleg bonds are driven into the rail web. Damaged connections are readily replaced by extracting the old terminals and driving new bonds.

Low-voltage amplifiers to dispense with high-voltage power sources.

The customary dynamotor, or other source of high-voltage power, for operation of amplifying apparatus associated with cab signal equipment on locomotives has been made obsolete by new developments in applications of modern, low-voltage vacuum tubes. New models of cab signal equipment introduced by the Union Switch & Signal Co., and the General Railway Signal Co., have incorporated the use of the modern tubes. Additional benefits have been derived by the elimination of other apparatus customarily required by the high-voltage tubes previously used, resulting in simplified equipment and consequent reduction in maintenance. Further advantages have been obtained by designs of amplifier units which make use of only one tube of the low-voltage type.

Electro-mechanical time switch lock.

The new style SL-8 electro-mechanical time switch lock, developed by the Union Switch & Signal Co., provides a switch lock which combines an electrically operated and a mechanical time release to enforce a time delay before the switch can be operated. This device eliminates the necessity for separate time element relays and associated wiring. Control may be arranged locally or from a distant point under control of an operator, and unlock may be obtained with or without time delay, as desired.

Consisting of an electric lock element and a self-starting clockwork time release, all mounted in a housing on a pedestal either on the ties or on a separate concrete foundation, the operation of the lock lever about 40 degrees from normal position starts the clockwork time release and also operates signals to their most restrictive indications. When the time delay has expired the lock magnet becomes energized and permits operation of the lock lever to the extreme reverse position to withdraw the locking plunger from a hole in the switch lock rod and unlocking the switch. When locking the switch, reversal of the procedure causes the clockwork time release to be rewound, the locking armature is forced to the locked position, and signals are restored to their usual positions.

Additional features are available, such as a sealed emergency release of the push button type so that trainmen can obtain direct release by breaking the seal and depressing the push button with the lock lever in the intermediate position. A telephone case may also be obtained for mounting on top of the SL-8 lock.

Plugboard for plug-in relays.

Wiring changes may be made more readily and quickly by the use of a new plugboard mounting for plug-in relays. Of molded bakelite construction, it is slotted to receive bakelite plugs which have metal terminals on either side with wires soldered to one side. The metal terminal locks into place in the plugboard but may be easily released and removed. When wiring changes are to be made, new terminals are provided with the new wires soldered to them, the old terminals are then removed and replaced by the new terminals when the change is made, all work being done from the back of the relay rack, making it unnecessary to disturb the relays. Two sizes of plugboards are provided, having totals of 22 and 44 terminals, respectively. They are also provided

with special binding posts to enable readings of current and voltage on the relay coils while the relay is in service.

The new plugboards are available from the General Railway Signal Co. for use with their Type B relays.

Hand tool for application of solderless terminals.

Improvement in the application of solderless wire terminals has been made by Aircraft-Marine Products, Inc. Faulty electrical connection between terminal and wire, generally the result of carelessness or operator fatigue when the terminals are installed with manually-operated tools, can be eliminated by the use of a new type tool known as "Certi-Crimp," wherein a simple device prevents re-opening of the tool for admission of a new terminal until the tool has been completely closed for the previous operation. The tool is so constructed that it cannot be tampered with, or changed, without obvious damage, insuring uniformity in the application of the solderless terminals.

Roadside motor car indicator for approaching trains.

The operation of motor cars has been given a means of added protection through the development of electric indicators which enable motor car operators to quickly determine if a train is approaching from the rear.

One type of indicator consists of a weatherproof unit housing an indication lamp, with push button combined in the same housing, and may be readily mounted on the side of a steel relay case along the right-of-way. These are located as conditions dictate, with control circuits extended back over as many track relays as required. When the button is pressed the lamp will light if the track circuits to the rear are unoccupied.

Another form of indicator utilizes the armature of a basic relay structure to actuate an indicating element consisting of two white-faced circular discs, so that when the relay coils are energized the rear disc is rotated to permit a green indication to be seen through holes in the front disc, and when de-energized a red indication shows. Scotchlite material is used for the color indications as it readily reflects light from a flashlight or motor car headlight for night indications. The entire unit is weatherproof, and arranged for mounting on a standard indicator post or bracket.

Indicators for this purpose have been made available respectively by the General Railway Signal Co. and the Union Switch & Signal Co.

Action Recommended

Acceptance as information.

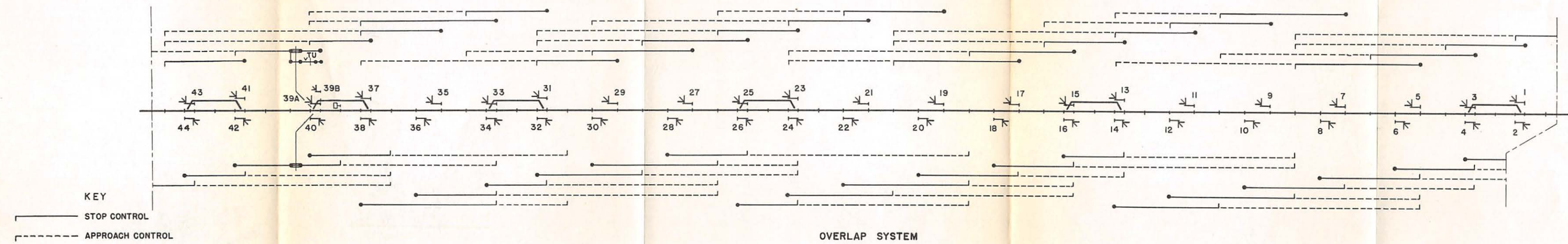
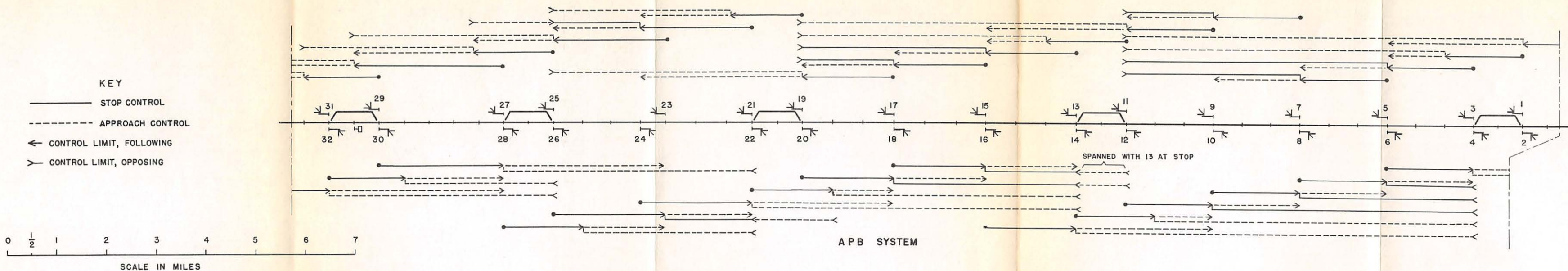
METHODS OF CONTROLLING SIGNALS IN SINGLE-TRACK,
AUTOMATIC BLOCK SIGNAL TERRITORY

Three basic general systems are in use: namely, the APB system, the overlap system, and the APB system with station overlap. The accompanying two charts show typical controls for each of these systems. They are all drawn to the same scale for purposes of comparison; however, the actual spacing of signals will depend upon local conditions, as well as speed and tonnage of trains. The controls are so arranged that proper restrictive indications are provided to protect both following and opposing movements.

The controls shown for the overlap system are based upon the assumption that opposing signals are not spaced stopping distance apart. Where opposing signals are spaced single or double stopping distance apart, the controls may be modified accordingly.

Action Recommended

Discussion.



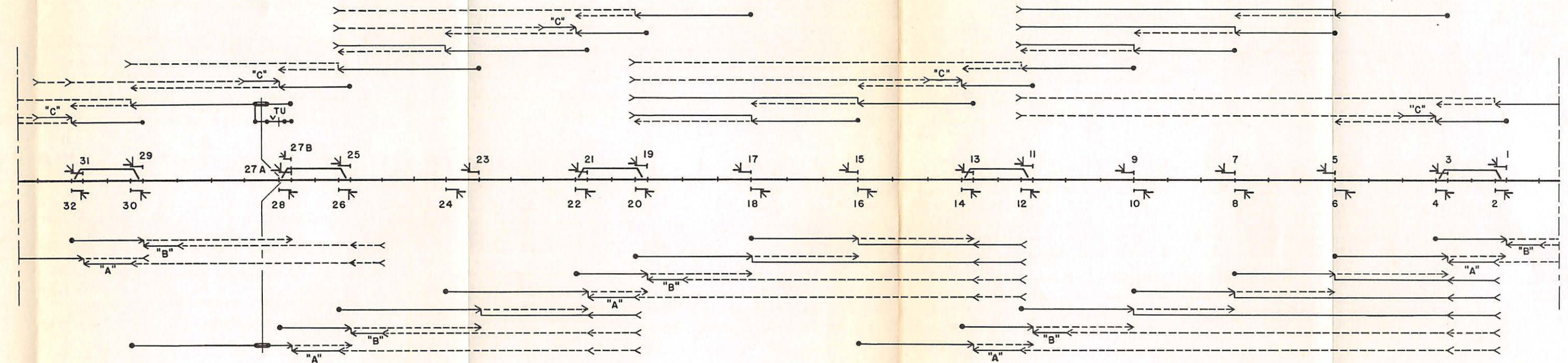
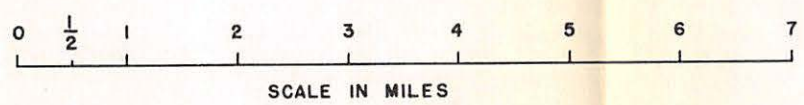
TYPICAL CONTROLS FOR AUTOMATIC BLOCK SIGNALS
ON SINGLE TRACK

NOTES

- A: STATION OVERLAPS "A" IN CONTROLS OF EASTWARD SIGNALS ARE SPANNED WHEN WESTWARD LEAVING SIGNAL INDICATES STOP.
- B: OVERLAPS "B" IN CONTROLS OF EASTWARD ENTRANCE SIGNALS ARE SPANNED WHEN WESTWARD ENTRANCE SIGNAL INDICATES STOP.
- C: OVERLAPS "C" IN CONTROLS OF WESTWARD ENTRANCE SIGNALS ARE SPANNED WHEN EASTWARD ENTRANCE SIGNAL INDICATES STOP.
- D: OPERATION OF PUSH BUTTON AT WESTWARD LEAVING SIGNALS SETS SIGNAL AT STOP PERMITTING EASTWARD SIGNALS TO CLEAR.
- E: OPERATION OF PUSH BUTTON AT ENTRANCE SIGNALS PERMITS SIGNAL TO CLEAR FOR SWITCHING MOVEMENTS

KEY

- STOP CONTROL
- - - APPROACH CONTROL
- ← CONTROL LIMIT, FOLLOWING
- > CONTROL LIMIT, OPPOSING



APB SYSTEM WITH STATION OVERLAP

COMMITTEE XI—ELECTRONICS

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J. E. Hillig	A. V. Dasburg*
J. M. Hoover	R. M. Laurensen*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Indexing signal literature.
2. Investigate and report on the use of electronic controls for railway signaling.
3. Report on electronic measuring apparatus applicable to railway signaling.
4. Report on various symbols and nomenclature used in electronic systems.
5. Principles of vacuum tubes, carrier systems and other electronic systems and devices.
6. Use of tube rectifiers, including electronic control of rectifiers.
7. Recommend basic design principles for electronic controls for railway signaling.
8. Investigate and report on use of electronic devices on trains to indicate proximity of other trains.
9. Investigate and report on the effects to both signal controls and communication when superimposing centralized traffic control circuits on existing dispatchers or other communication circuits, collaborating with Communications Section, A.A.R.
10. Electronic tubes for use in signal apparatus, recommendation to cover type and designations of tubes to meet various requirements.
11. Investigate and report on the practicability of using frequencies above 30 k.c., for carrier circuits used in centralized traffic control.
12. Investigate and report on the use of electronic switches in lieu of electromagnetic relays.
13. Requisites for electronic devices for use in railway signaling.
14. Instructions for shop and field testing of electronic equipment used in railway signaling.

* Consulting Member.

The Committee submits for consideration, reports on the following subjects*:

2. Electronic track circuit.

Micro-wave beamed radio on the Long Island R.R., Jamaica-Floral Park, N. Y.

4. Electronic Terms and Symbols Used in Signaling.

5. Electronics as Applied to Railway Signaling.

Explanatory

With the ever increasing application of electronic devices to railway signaling systems, there exists a real need for complete understanding of, and agreement upon, the symbols and terms employed in describing them. There is little, if anything, unique in the application of electronic equipment to railroading which demands use of special symbols. The American Standards Association, in which the Association of American Railroads is a participant, has for many years, labored to establish, throughout the electrical industry, complete agreement upon graphical symbols and terminology. In the field of electronics, this is now essentially an accomplished fact.

The proper use of graphical symbols and the preferred definitions of terms for electronic devices and systems has been carefully studied in Committee and it was found that suitable sections of the A.S.A. Standards provide the most adequate expressions. Accordingly, it is recommended the symbols and terminology as presented under assignment 4, be adopted by the Signal Section as preferred practice.

The definitions of nomenclature were taken from Group 70, Electronics, A.S.A. Standard C42-1941, "American Standard Definitions of Electrical Terms," and are those terms associated with electronic systems. The listing is complete, with the exception of section covering x-ray tubes which was omitted since little or no application is anticipated in railway signaling for such terms.

The graphical symbols were taken from approved A.S.A. Standards Z32.5-1944, "Graphical Symbols for Telephone, Telegraph and Radio Use," and Z32.10-1948, "Graphical Symbols for Electronic Devices," and are those required to adequately express circuits for electronic devices and systems as used in railway signaling.

Information

Specifications, etc., of other organizations referred to in the report of this Committee may be procured from the following:

A.S.A.—American Standards Association, 70 E. 45th St., New York 17, N. Y.

A.I.E.E.—American Institute of Electrical Engineers, 33 E. 39th St., New York 18, N. Y.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

ELECTRONIC TRACK CIRCUIT

The electronic track circuit for crossover protection shown in Fig. 1 was developed to increase sensitivity (resistance of the contact between wheels and rails), to maintain more uniform shunting throughout the wide differential between low and high ballast resistance, to insure maximum broken-rail protection with and between minimum and maximum ballast resistance and to allow a potential of sufficient magnitude to be applied to the rails to cause ionization of the rust film between the rails and wheels.

The circuit is so designed that a failure or opening of one or more components or the opening of any part of the circuit will cause the signals controlled to display their most restrictive indication.

The high sensitivity is obtained by the use of two four-electrode thyatrons of the indirectly heated cathode type designed for use in relay applications. The shield grid in this application is used as a control electrode to shift the control characteristics of the control grid; as the shield grid is made more negative, the control grid characteristic is shifted in the positive direction, thus for any specific shield grid potential and positive anode potential, there is a critical value of control grid voltage which will permit conduction of the anode current to start. If the control grid voltage is maintained more negative than the critical value the tube does not conduct and the anode current remains zero.

Once conduction has been initiated the control grid loses effectiveness and cannot be used to control or stop conduction even though it becomes more negative. In order for the grid to regain control and restore the tube to the non-conducting condition, the anode potential must be disconnected momentarily, reduced below the requisite ionization potential, or by applying a negative impulse to the anode. On an alternating current supply the anode potential becomes negative during the negative half of the alternating current cycle and the grid may therefore regain control. If the grid is made sufficiently negative it can prevent conduction on a subsequent cycle.

In alternating current operation, control of the average anode current may be accomplished by relative phasing of the control grid, shield grid and anode potentials. Phasing in this application is accomplished by using the instantaneous polarities of the several transformer windings, thus in the positive half of the alternating current cycle the anode and control grid are positive when the shield grid is negative and in the negative half of the alternating current cycle the anode and control grid potentials are negative when the shield grid is positive.

The critical control grid voltage for any given anode voltage is that value of control grid voltage which will permit conduction to start. The value of the critical control grid voltage is affected by several factors including the operation anode voltage, shield grid voltage and value of the grid resistor.

The magnitude of the control grid current during conduction for a given control grid potential is very small and is affected by the magnitude of the anode current. The magnitude of the anode current depends only on the anode load impedance and applied potential.

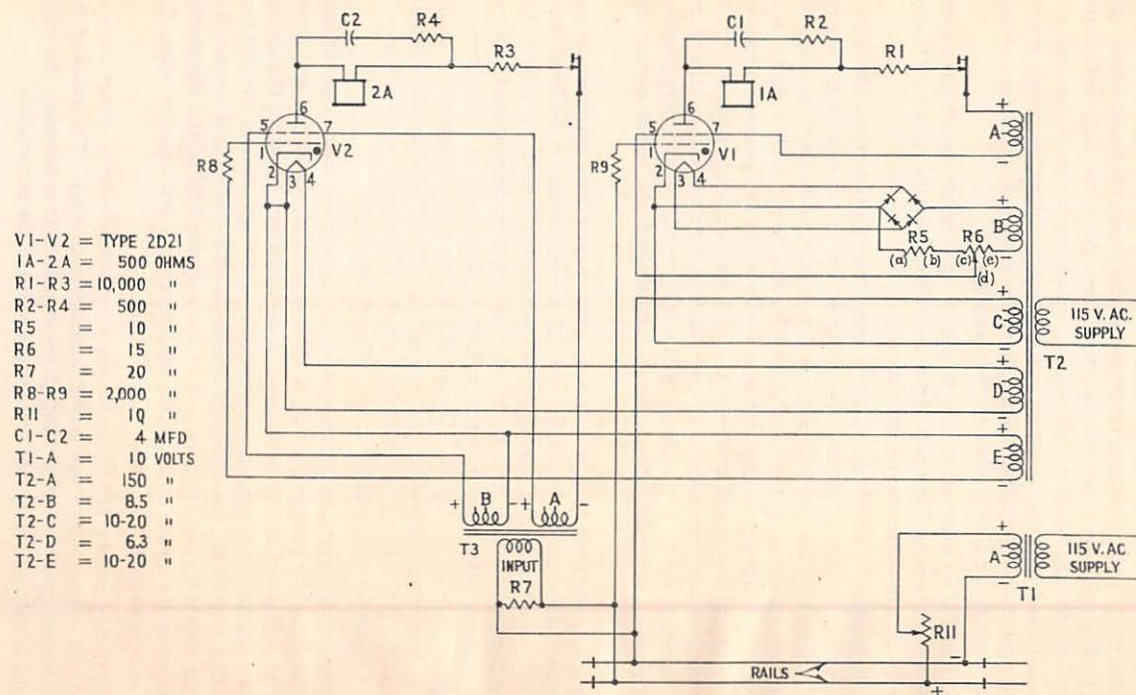


FIG. 1

Tests made on various tubes of the type used indicate that the tube is most sensitive with a critical control grid potential of 24 volts and an anode potential of 150 volts. The anode load is a conventional type 500-ohm relay with a capacitor and resistor combination connected in multiple across the coils and a resistor in series to limit the anode current flow. The capacitor resistor combination is used to ^{prevent} retard the release of the relay during the negative half of the alternating current cycle when the tube is not conducting. Thus with the aforementioned control grid voltage and a certain negative shield grid potential, a drop in the control grid potential of less than 0.020 volt will stop the tube from conducting. However, the control grid current being very small, less than 10 milliamperes, a series resistance of a value higher than desired for broken-rail protection is required to reduce the control grid voltage below the critical value.

From the foregoing, three desirable factors for track circuit detection obtain: namely, high resistance shunting sensitivity, high potential across rails to permit ionization between rails and wheels and inasmuch as anode conduction and control grid voltage are removed every half cycle, a resistance or train shunt across the rails need only prevent the control grid voltage from rising to the critical value to start conduction. The disadvantage of the very small control grid current flowing in the rails is overcome by the use of the second tube.

When the track circuit is unoccupied both tubes V1 and V2 are alternately conducting and relays 1A and 2A remain in their energized position. The circuit for tube V1 and relay 1A (referred to as the detection tube and relay) will be described first.

The anode potential for the detection tube is obtained from plus terminal of winding A on transformer T2 through current limiting resistor R1 through coils of relay 1A and capacitor resistor (C1-R2) combination to anode terminal 6 of tube V1, cathode terminal 2 to rectifier, through resistor R5 and part of potentiometer R6 from adjustable contact arm on potentiometer R6 to shield grid terminal 5 on tube V1, through shield grid, out terminal 7 tube V1 to minus terminal of winding A transformer T2.

To insure against the loss of the negative shield grid potential a full-wave rectifier is connected to winding B of transformer T2 in series with resistor R5 and potentiometer R6, the direct current output supplies the heater current terminals 3 and 4 tube V1. Across terminal (a) of resistor R5 and terminal (c) of potentiometer R6 there is an alternating current potential with terminal (a) more positive and connected to the cathode; resistor R5 insures that the adjustable contact (d) on potentiometer is always more negative than terminal (a) on resistor R5 on the positive half of the alternating current cycle. Shield grid terminal 5 tube V1 is connected to terminal (d).

To avoid applying any higher control grid potential to the rails than necessary to cause ionization of the rust film between the rails and wheels and yet maintain the most critical control grid potential, winding C of transformer T2 is made additive to track transformer T1. Control grid potential is obtained from plus terminal of transformer T1 through limiting resistor R11, plus rail and grid resistor R9 to control grid terminal 1 of tube V1. Cathode terminal 2 is connected to minus of winding C of transformer T2, the plus terminal of winding C of transformer T2 is connected in series to minus of transformer T1 in series with minus rail.

To provide broken-rail protection and maintain more uniform shunting sensitivity, the maximum resistance of the rail circuit is limited to a predetermined value, a resistance R7 is connected across the rails at the relay end. To insure the integrity of resistor R7 the primary of transformer T3 is connected in parallel with R7. Secondaries A and B of step-up transformer T3 are used to supply the anode and shield grid potentials of tube V2 and energize relay 2A (referred to as the integrity relay).

The anode potential for tube V2 starts from the minus terminal of winding A transformer T3, through resistor R3, coils of relay 2A and to anode terminal 6 tube V2, (capacitor C2 and resistor R4 perform the same function as described for relay 1A), from cathode terminal 2 tube V2, to minus terminal winding B transformer T3, plus terminal of winding B transformer T3, to shield grid terminal 5, through shield grid, terminal 7 to plus winding A of transformer T3. From the foregoing it will be seen that anode and shield grid potentials are obtained from windings A and B transformer T3, control grid and heater potentials are obtained from windings D and E transformer T2. The instantaneous polarities of the potentials applied to tube V2 are 180 degrees out of phase with the potentials applied to tube V1, thus tube V1 conducts on the positive half of the alternating current cycle and tube V2 conducts on the negative half of the alternating current cycle.

Adjustments.

Detection tube: The shield grid potential is adjusted to a value (by potentiometer R6) that will not permit conduction of the anode current to start when the control grid potential has decreased to some minimum value determined by combined impedance of resistor R7 transformer T3 and the minimum low ballast or when a shunt resistance is applied across the rails.

Integrity tube: With predetermined minimum ballast resistance the anode potential is established by selecting same by means of the tapped secondary winding A of transformer T3 for a given maximum ballast resistance for the purpose of limiting the anode potential. A value of shield grid potential is selected that will permit the tube to conduct with the fixed control grid voltage, thus when the voltage impressed on the input winding of transformer T3 is reduced by a shunt resistance or a series resistance (train shunt or broken rail) the anode potential is reduced below the requisite ionization potential. Should resistor R7 open, the potential across the input of transformer T3 will increase, thus the secondary voltage of winding B of transformer T3 will increase and the shield grid potential increases to a value that will not permit conduction to start. As mentioned previously, the shield grid is used as a control electrode. To insure against the loss of the shield grid electrode, its potential or any connections to it, the relay circuits are connected in series with it.

Action Recommended

Acceptance as information.

MICRO-WAVE BEAMED RADIO ON THE LONG ISLAND R.R.,
JAMAICA-FLORAL PARK, N. Y.

Micro-wave beams may be substituted for open wire or cable for point to point transmission of communication and signaling system in formation.

A test was made to determine the merits of the micro-wave radio beam system for remotely operating the following: centralized traffic control, telephone ringing, call selector, voice and call, facsimile, teletype, supervisory control, and telemetering.

Micro-wave radio equipment consists of a micro-wave transmitter and receiver, suitable for use as a two-way relay terminal or a one-way repeater, all contained in a single cabinet 26 inches wide by 19 inches deep by 75 inches high, weighing approximately 700 pounds. The equipment is subdivided functionally into component unit assembled on standard relay rack panels and interconnected within the cabinet. This method of construction provides maximum ease of accessibility to all components.

The equipment provides a single band having a flat response from 200 cycles to 200 kilocycles. Direct frequency modulation of the RF carrier to a deviation of plus or minus 400 kilocycles is obtained by modulating the reflector electrode of the transmitter reflex Klystron. The modulator is a low gain linear amplifier. The receiver is a single superhetrodyne with a wave guide mounted crystal mixer followed by a 30 megacycle IF amplifier which has a 2 megacycle band width between points 3 decibels down. It has a signal-controlled AFC (automatic frequency control) which is instantaneous in action.

The transmitter Klystron has a nominal power output of 1 watt. The same tube type, operating at lower power, also is used as a local oscillator in the receiver. Transmitter AFC provides long-term frequency stability better than plus or minus 0.005 per cent. This unit also monitors the modulation index of the frequency modulated emission.

The multiplexing method used with this equipment is termed "frequency-division multiplex." In this system, a continuous micro-wave beam is emitted and many subcarriers are superimposed, separated from each other by frequency. Sub-carriers frequency modulate the micro-wave as a group.

The frequency band occupied in the spectrum by the emitted energy is a summation of two components: that which is required by carrier frequency tolerance, which in this equipment is plus or minus 0.005 per cent or 0.66 megacycle at 6,600 megacycles, and that which is required by the method of multiplexing.

Transmitter characteristics

Frequency.....	5,925-7,125 MC
Power output.....	1 watt
Modulation.....	Frequency
Modulation deviation.....	± 400 KC
Modulation index.....	2
Frequency control.....	Automatic (crystal reference)
Frequency stability.....	± 0.005 per cent.
Maximum RF band width required.....	2.26 MC
Typical RF band width required.....	1.26 MC

Transmitter characteristics	
Modulation channel response.....	200 to 200,000 CPS $\pm$ 0.1 db
Input level.....	-10 dbm
Input impedance.....	600 ohms balanced
Receiver characteristics	
Frequency.....	5,925-7,125 MC
Selectivity.....	2 MC (-3 db), 10 MC (-60 db)
Frequency control.....	Automatic, signal control
Output channel response.....	200 to 200,000 CPS $\pm$ 0.1 db
Output.....	+ 6 dbm
Output impedance.....	600 ohms balanced

Legend:

MC = megacycles
KC = kilocycles
db = decibel

CPS = cycles per second
dbm = decibels above or below one milliwatt

Transmitter power, receiver sensitivity and antenna gain is such that over a beam path up to 60 miles, a slow or rapid signal fade of -20 decibels to +6 decibels from normal will permit normal operation from the circuit.

Signal-to-noise ratio at the received output is at least 50 decibels for free-space radiation of a beam path length up to 60 miles for normal transmitter power output with the input level 6 decibels below that to produce full modulation of the transmitter. Under multiplexing operation, the total harmonic content is less than 0.2 per cent and intermodulation distortion is down at least 54 decibels. Circuits are shielded against noise frequencies such as may be induced from nearby power lines or electrical equipment.

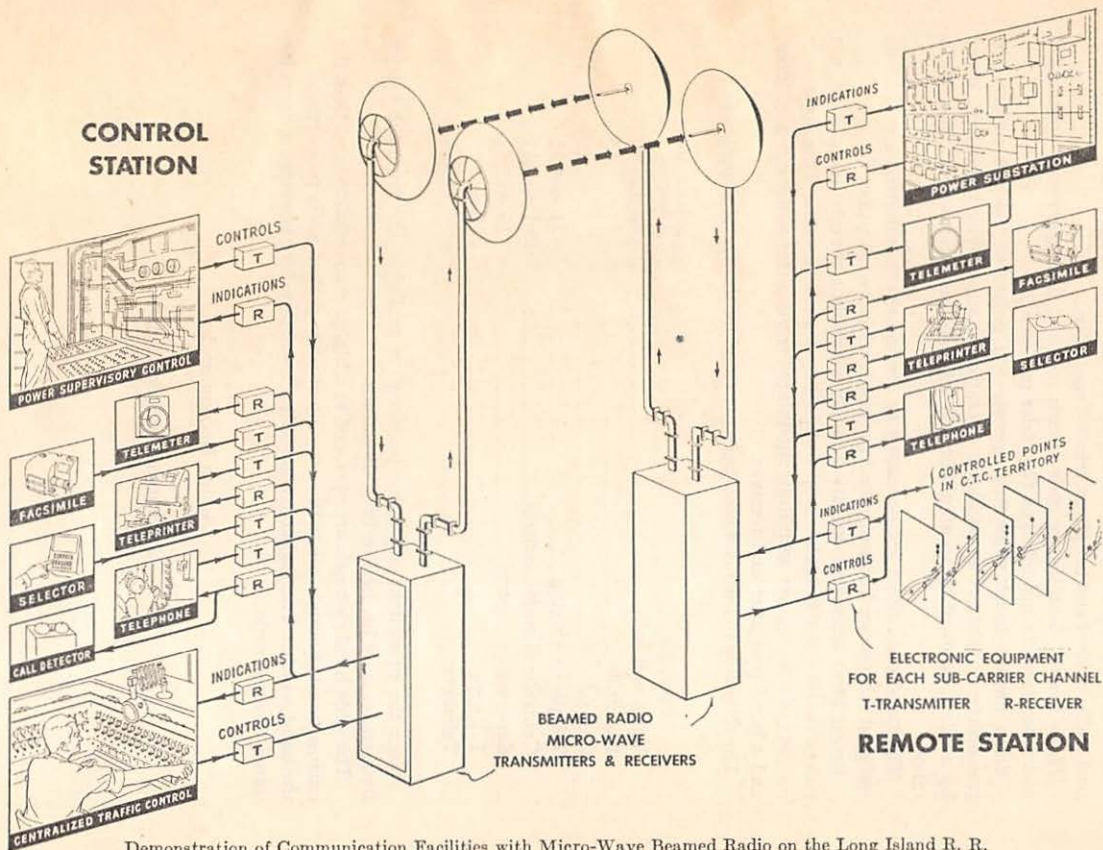
The parabolic antenna for moderate range is 4 feet in diameter and presents a dead weight load of approximately 40 pounds and a wind load of approximately 350 pounds at a wind velocity (true) of 100 miles per hour. Two antennae are required for each equipment, one for transmitting and one for receiving.

Antenna characteristics	
Type.....	48-inch waveguide-fed Paraboloid
Gain.....	35 db
Vertical beam width.....	3 degrees
Horizontal beam width.....	3 degrees
Polarization.....	Vertical or horizontal

The sub-carrier apparatus is standard equipment which normally operates over wire lines. It is classified as follows with respect to band width:

Narrow band equipment is used where the operation to be performed is accomplished by merely turning the sub-carrier on or off. Such operations may be, and usually are, coded. This type of operation is adequate for supervisory control, centralized traffic control, and telephone selector operation. The band width employed for these purposes is approximately 200 cycles per second.

Broad band equipment is used for voice frequency range (200 to 3,000 cycles per second). This range of frequencies has been provided for voice



Demonstration of Communication Facilities with Micro-Wave Beamed Radio on the Long Island R. R.

communication and facsimile. In this classification the sub-carrier is modulated to a total band width of plus or minus 3,000 cycles per second.

Under the narrow band classification, sub-carrier apparatus may be classified further into types as:

Low speed: Up to seven codes per second which is adequate for centralized traffic control and telephone selector operation.

High speed: Suitable for code speeds required for supervisory control (15 codes per second) and teletype (25 codes per second).

Since narrow band apparatus operates on pulses of the sub-carrier, the transmitter consists of an oscillator operating at sub-carrier frequency, keyed by a relay, followed by an amplifier and a band-pass filter, an amplifier and a relay.

The band-pass filters are necessary to confine the transmitted signal to its assigned sub-carrier frequency, and to permit selective reception.

Broad band apparatus operation involves handling the continuous (i.e., not pulsed) sub-carrier modulated up to 3,000 cycles per second. This apparatus consists of a low-power amplitude modulated transmitter and band-pass filter, and a band-pass filter and receiver.

The following frequencies have been provided for the various operations:

Operation	Sub-carrier frequency, kilocycles
Voice and call.....	65 and 45
Facsimile.....	45
Call selector.....	23
Telephone ringing.....	21 and 15
Centralized traffic control.....	19.1 and 11
Supervisory control.....	17 and 13
Teletype.....	13 and 17
Telemeter.....	25.4

Since the equivalent of a four-wire circuit is available, the same sub-carrier frequencies may be used in both directions.

The wide band channels are operated at a higher transmission level than the narrow band channels, since the amount of noise picked up is proportional to the band width. The higher transmission level therefore provides a desirable signal-to-noise ratio.

Action Recommended

Acceptance as information.

ELECTRONICS AS APPLIED TO RAILWAY SIGNALING

THE ELECTRONIC TUBE

General.

An electronic tube controls the flow of electric current through a circuit, much as a valve controls the flow of water through a pipe. Wires carry electric current to the tube and, after it has passed through the tube, other wires carry it away through the rest of the circuit.

Unlike the valve, the electronic tube has no moving parts and no mechanical inertia to overcome. Its action is completely electrical; therefore, it operates with the speed of electricity—and that is one of its most valuable features.

Just as the flow of water in a pipe is the combined movement of a great many drops of water, the flow of electricity in a conductor, such as a copper wire, is the combined movement of a stream of electrons. Each electron carries a tiny quantity of electricity. As long as electrons remain imprisoned in wire, control over them is limited; but if they can be liberated from the wire under controllable conditions, such as exist within a sealed glass or metal bulb, their usefulness can be greatly increased. That is where the electronic tube fits into the picture.

When an electronic tube is connected into an electric circuit, the conductor is actually broken, leaving a gap within a sealed enclosure. Electricity must flow across this gap in order to close the circuit and permit current to flow again. An invisible stream of electrons (each electron carrying a tiny quantity of electricity) carries the current through the space in the tube. During the split second when the electric current is a flow of "free" electrons in the tube, it is subject to a method of control which is not possible while electrons are imprisoned in the wire. The current can be stopped, started again, increased or decreased—instantaneously, smoothly, accurately, and without mechanical movement, noise or vibration. A high-speed mechanical relay or switch is slow by comparison.

Some electronic tubes can smoothly and precisely increase or decrease the amount of current flow. Others can instantaneously stop or start the full flow of current. Another valuable feature is that only a tiny amount of energy is required to control a large amount of current flowing through the tube.

Inasmuch as there are two main classes of tubes, the high-vacuum and the gas-filled, an explanation of the basic differences between them is given in this write-up.

Since there are many types of gas-filled and high-vacuum tubes, it is impractical to describe them all in a single report. However, the basic principles of all tubes are essentially the same, and a thorough understanding of one tube will make it easy to understand the operation of all electronic tubes.

Basic parts of a triode.

To clearly illustrate and explain the operation of electronic tubes, the widely used triode has been selected. The following will describe the basic parts, construction and operation of a triode or three-element tube.

Figure 1 shows the glass or metal envelope (the outside of the tube).

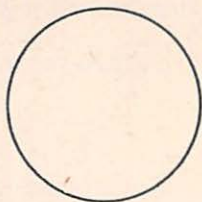


Fig. 1.

Certain tubes have a separate heating coil, shown in Fig. 2, to bring the cathode to the temperature required to make it give off electrons.

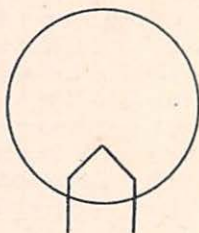


Fig. 2.

The surface which gives off electrons, known as the cathode, is shown in Fig. 3.

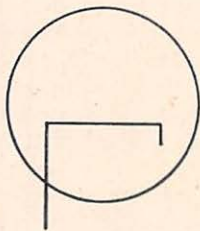


Fig. 3.

The surface which receives electrons, known as anode or plate, is shown in Fig. 4.

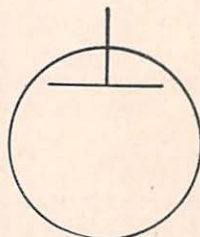


Fig. 4.

The grid which controls the current passing between the cathode and anode is shown in Fig. 5.

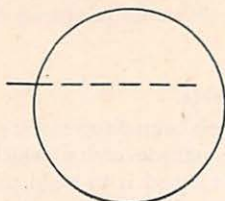


Fig. 5.

The assembled basic parts within the envelope are shown in Fig. 6. The dot indicates a gas-filled tube. Where the dot is not shown, the tube is of the high-vacuum class.

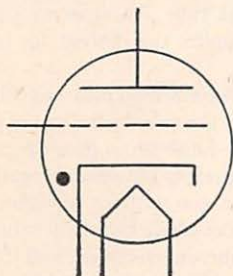


Fig. 6.

There are two basic classes of electronic tubes: high-vacuum and gas-filled.

In making a gas-filled tube, the air is first pumped out until a high vacuum is created. Then, before the tube is sealed, a tiny quantity of argon, neon, mercury vapor, or some similar substance is inserted. (However, the pressure is still well below that on the outside of the tube.) This gas or vapor is chemically inert, which means that it will not combine with any of the metals used in the tube.

Both types are necessary, since each possesses characteristics either lacked by the other or superior to those of the other. Generally speaking, gas-filled tubes are necessary where large amounts of current must be controlled, as in resistance welding. High-vacuum tubes are necessary in jobs calling for continuous control of relatively small currents.

The major distinctions between gas-filled and high-vacuum tubes are these:

1. High-vacuum tubes work like a throttle in that they provide continuous and uniform control of the amount of current flowing through the tube.
2. Gas-filled tubes work like a switch. They are capable of accurately and instantaneously closing a heavy-current circuit.
3. Gas-filled tubes will carry heavy current much more efficiently than high-vacuum tubes of the same size. This heavy current is conducted with a low and relatively constant voltage drop.
4. High-vacuum tubes can be used as distortionless amplifiers; gas-filled tubes cannot.

A gas-filled tube is also a relatively high-vacuum tube, for the gas it contains is at an extremely low pressure. The presence of this small amount of gas, however, is the key to the difference in operation of the gas-filled and high-vacuum tube.

Operation of the basic parts.

In most tubes the cathode is heated to make it give off electrons. There are two methods of heating the cathode, each of which has special advantages for certain applications. One method is to build the cathode in the form of a filament which is heated by its own resistance when a current is passed through it. These self-heated filament cathodes look much like the filament of an incandescent lamp. The other method is to use a separate heating coil inside the cathode. This heating coil is called a heater. The heater is made of a metal with a high melting point, such as tungsten. Operating temperatures vary. The cathode is not heated to its operating temperature by the main current flowing through the tube. A separate circuit, fed by a low-voltage transformer or battery, supplies the current for heating either the filament-type cathode or the heater.

When an electronic tube is connected into a circuit, the conductor is actually broken. The cathode inside the tube is one end of a broken conductor and the anode is the other. To re-establish a flow of current through the circuit, electrons must flow across the gap between the cathode and the anode. Electrons cannot get across this gap without assistance. They must first be released from the cathode so the anode can "pull" them across the gap. Heating the cathode is one way to liberate electrons, and it is the method used in most tubes. When the cathode is heated, electrons boil off the surface—much as steam is boiled off the surface of water. Heated cathodes, whether of the directly or indirectly heated type, are made of a metal having a high melting point, such as nickel-alloy, coated with certain chemical compounds to increase their ability to give off electrons. Whether a cathode should be directly or indirectly heated depends on the electrical characteristics desired for the tube and the materials used. Filamentary (directly heated) cathodes heat more quickly than indirectly heated cathodes and are used where quick heating is desired. A much larger emitting surface can be heated efficiently with the indirect method. Therefore, indirectly heated cathodes are generally used in tubes which are expected to carry large currents.

The anode or plate is the other end of the broken conductor in the tube. It attracts the billions of electrons that are "boiled" off the surface of the cathode, thus establishing a flow of current through the tube, which is called the "plate current." While the anode (or plate) can attract electrons, it is incapable of giving off electrons as long as the tube is operating at the proper temperature. When a positive voltage is applied to the anode, Fig. 7-a, it attracts the electrons given off by the cathode. The reason for this is that electrons are always negatively charged, and opposite electrical charges attract each other. Therefore, if the tube is being used in a direct current circuit, the anode must always be connected to the positive side of the circuit.

When a tube is connected into an alternating current circuit, the anode is positive during half of each cycle. During this half cycle electrons leave the cathode and are attracted by the anode, resulting in a flow of current through the tube. During the half cycle when the anode is negative, Fig. 7-b, electrons

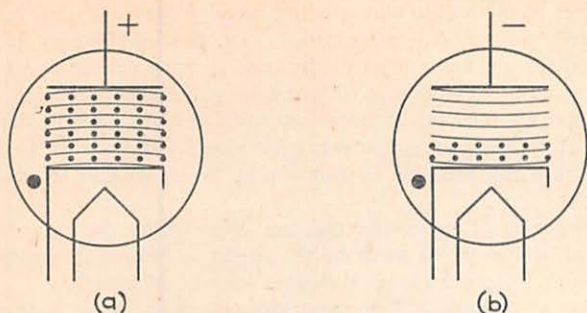


Fig. 7.

cannot reach the anode. During this half cycle, current cannot flow through the tube. It is this characteristic of an electronic tube which enables it to act as a rectifier, changing alternating current into direct current. The higher the positive voltage applied to the anode, the greater its ability to attract electrons, and the greater the rush of electrons to it—up to the limit of the ability of the cathode to give off electrons.

Different materials are used in fabricating anodes. They include tungsten, molybdenum, nichrome, graphite, nickel, and tantalum. Different shapes, also, are used. Material used and shape selected depend on the desired electrical characteristics and the amount of cooling necessary.

The grid is the controlling or "valve" element of the tube and is located between the cathode and the anode in the path of the electrons. The grid will not permit electrons to reach the anode as long as a certain negative voltage value is maintained on the grid, Fig. 8-a. When this voltage becomes less negative, the grid works like a trigger, suddenly permitting the full flow of electrons to start toward the anode, Fig. 8-b. The grid in any gas-filled tube controls only the point in the cycle at which electrons will start to flow to the anode. Once the flow of electrons has started, the grid in any gas-filled tube loses control over the flow until the next cycle; that is, until the anode has become negative and stopped the flow of electrons, Fig. 8-c. After the flow of electrons has stopped, the grid regains control, and once more will prevent the start of the flow until voltage on the grid again becomes less negative.

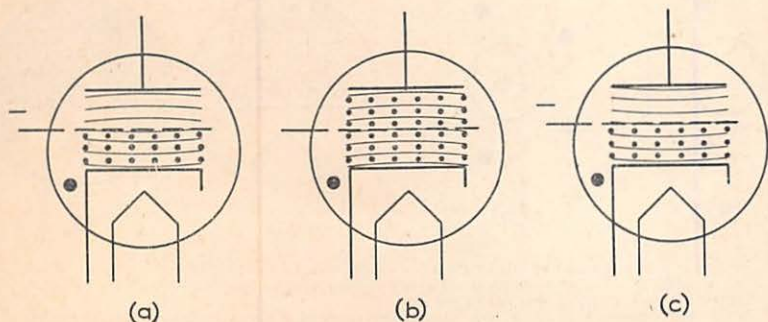


Fig. 8.

The effect of the grid in high-vacuum tubes is quite different, for it never loses control over the flow of electrons. The flow of electrons at all times depends on the voltage applied to the grid, and any change in grid voltage causes a change in the amount of current flowing through the tube.

In both the gas-filled and high-vacuum tubes, the power required in the grid is very small. Therefore, a relatively small amount of power in the grid of an electronic tube can precisely control a much larger amount of power in the plate circuit.

In both classes of tubes, electrons are given off by the cathode. These electrons are drawn to the anode by the attractive force of its positive charge (remember that opposite electrical charges attract each other).

The effect of the billions of electrons passing between the cathode and anode is to create a strongly negative electric field (remember that electrons are always negative). This field is known as "space charge."

This negative field, due to the space charge, cancels part of the positive field created by the anode, thus reducing the ability of the anode to attract electrons. This is known as "space-charge effect" and is the basic reason for the inability of high-vacuum tubes to carry as large a current for their size as gas-filled tubes.

When a small amount of gas is placed in the tube it fills the space in the tube with gas molecules which, by comparison to the tiny electron, are very large. A gas molecule consists of a nucleus, which is positively charged, and a number of electrons which revolve about it much like the planets of a miniature solar system. There are just enough electrons to balance the positive charge on the nucleus and make the molecule electrically neutral.

Electrons emitted by the cathode travel with tremendous velocity and when one of them collides with a gas molecule the impact knocks one or more electrons out of the molecule. These molecules, which have lost some of their electrons and are now positive, are called ions. The process is called "ionization," as shown in Fig. 9.

The electrons knocked out of the molecules join with the stream of electrons moving toward the anode. The ions remain in the tube for a relatively long time and neutralize most of the effect of the space charge. The effect of ionization is to permit more electrons to reach the anode. Thus, ionization is responsible for the greater current-carrying capacity of gas-filled tubes.

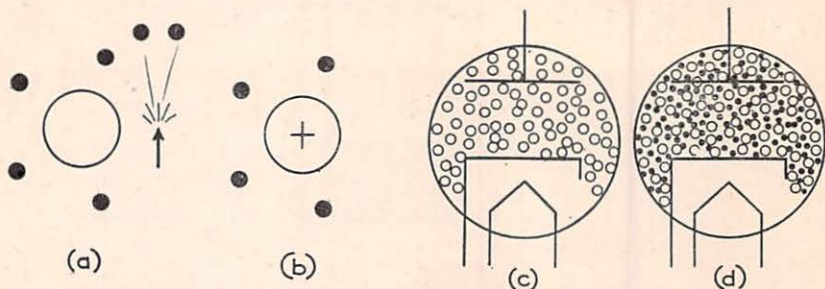


Fig. 9.

- (a) An electron is knocked out of a neutral gas molecule.
- (b) A molecule which has lost an electron is no longer neutral, but is positive.
- (c) These positive molecules are called ions.
- (d) When enough ions form, they neutralize most of the space charge, permitting more electrons to reach anode.

Applications.

In practical applications, the tube is only one part of an assembly of apparatus designed for a specific use. The following applications will be described:

Rectifier
Amplifier
Oscillator
Modulator
Detector or demodulator

The accepted theory of current flow is from positive to negative, while the motion of the electrical unit, the electron carrying a negative charge, is from negative to positive. This contradiction can be confusing, particularly when electron tube circuits are being studied, unless the reasons for the contradiction are understood.

Electricity was known and used for many years before its nature was understood. Early investigators knew that something happened in a piece of wire to heat it, or cause a compass needle to swing, when the ends of the wire were connected to a battery. They pictured this "something" as being of a liquid nature. Electricians still call electricity "juice." They recognized that the two terminals of a battery are different and decided to call one positive and the other negative. Probably reasoning that positive implies something higher than negative, and since water runs down hill, therefore, electric current flows from positive to negative. Note that this choice of direction was entirely an accident of selection. The selection was agreed upon on the basis of the best information at hand. So far as the original investigators knew, the electrical unit (electron) could have been positive. Unfortunately, later discoveries showed that the basic unit is negative and moves from negative to positive.

In this description the actual motion of electrons is only of interest within the tube itself. Therefore, when electron motion is mentioned, it will be understood that the direction is from negative to positive but that this electron motion constitutes a current flowing in the conventional direction from positive to negative.

Terms such as "plate voltage," "grid bias voltage," etc., are used frequently in discussing electron tube circuits. It will be understood that such voltages are measured at the terminals of the tube, with the cathode terminal as the reference point. For example, the grid bias voltage will be the voltage measured from the cathode terminal to the grid terminal.

For the sake of simplicity in drawing circuits, the heater wiring is frequently omitted and the cathode only shown. In such cases it will be understood that proper heater power is furnished.

Rectifier

As already mentioned, certain chemical compounds or metals, when heated, emit or "boil off" electrons. These electrons travel a short distance from the emitter, or cathode, and gather in a cloud around it. This cloud of electrons is known as space charge and is negative since each electron in the cloud carries a negative charge. However, electrons in escaping from the cathode leave the cathode with an equal positive charge which tends to draw them back. Thus, a state of equilibrium is reached such that the cloud of electrons held in the

space around the cathode is proportional to the heat energy supplied to the cathode from the heater. When the heat energy is turned off, electrons in the space return to the cathode. This phenomenon occurs in other devices such as an incandescent lamp. The fact that practically all the emitted electrons return to the cathode, in a single-element tube such as a lamp, explains why the boiling off process does not rapidly use up all the material of the cathode.

To change a tube with only an emitting element, or cathode, into a rectifier, it is necessary to add a second element called an anode, or plate. The plate is made of conducting material, usually metal, which surrounds or is placed near the cathode. The tube then becomes a diode which means two-element. If an external battery is furnished, with the negative terminal connected to the cathode and the positive terminal connected to the plate, electrons emitted by the cathode, instead of collecting in the space around the cathode will be attracted by the high positive potential of the plate and will move to it. This will permit more electrons to "boil off" of the cathode. These additional electrons are replaced by electrons which travel from the plate battery to the cathode. That is, a stream of electrons travels from the cathode to the plate within the tube, or using the convention for current direction, a current flows from the plate to the cathode within the tube. If the battery connections to the tube are reversed so that the plate is negative and the cathode positive, the electrons will be repelled by the negative potential of the plate and, therefore, no electron motion or plate current will result. Therefore, a diode will permit current to flow if the plate is positive, but will block current if the plate is negative. This action is shown in Fig. 10.

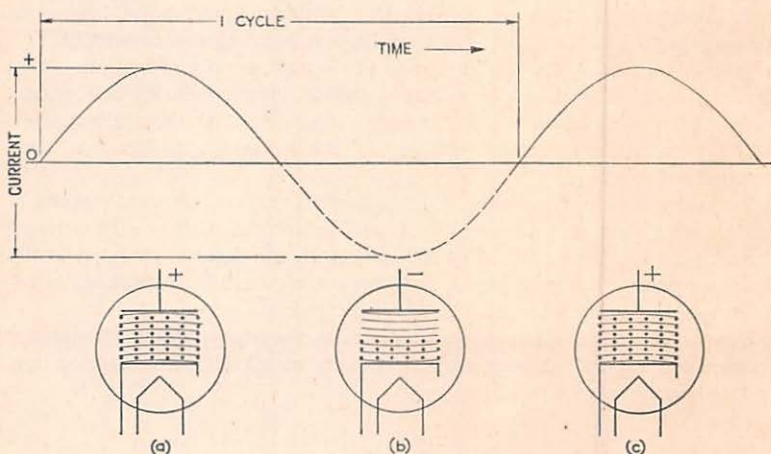


Fig. 10.

- (a) Anode is positive and attracts electrons.
- (b) Anode is negative and does not attract electrons.
- (c) Cycle repeats.

Figure 11 shows a diode connected to a transformer which gets power from an alternating current source such as the 117-volt 60-cycle supply. The voltage from the transformer is shown by graph (a) and the current which flows

through the rectifier tube is shown as graph (b). The current is direct current, made up of a series of half-wave pulses known as half-wave rectification.

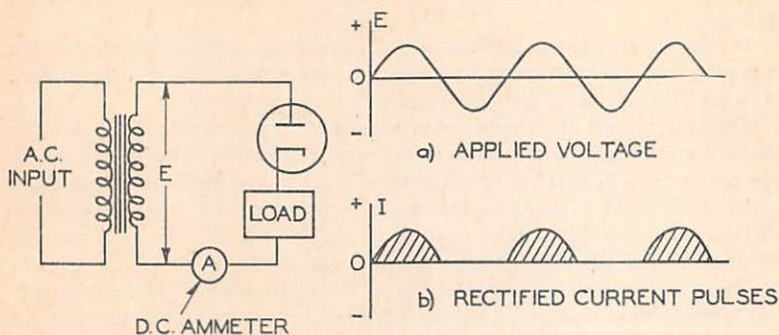


Fig. 11.

Diode Rectifier—Half Wave.

Figure 12 shows two diodes connected back to back, with a center tapped transformer. This arrangement is a full-wave rectifier. When the alternating current potential is such that transformer terminal 1 is positive, current will flow through diode 1 as shown by the solid arrow. On alternate half cycles when the potential is such that transformer terminal 2 is positive, current will flow through diode 2 as shown by the dotted arrow, in the same direction as from diode 1. The voltage from the transformer is shown in (a) and the current through the load is shown in (b). The current is again a series of half-wave pulses, except that both halves of the original wave are used, and is therefore known as full-wave rectification.

Other rectifier circuits are possible. Four tubes can be used in a bridge circuit to provide full-wave rectification without the necessity for a center tap on the transformer. Two or more tubes can be connected so that the direct current output voltage is higher than the supply voltage. Such circuits are known as doubling or tripling circuits.

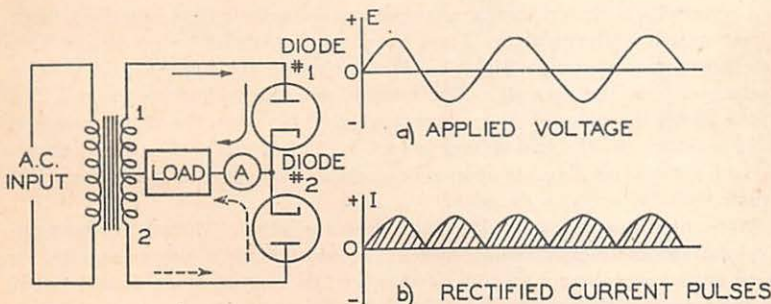


Fig. 12.

Diode Rectifier—Full Wave.

Amplifier

The ability of an electron tube to function as an amplifier is one of its most useful characteristics and is used in some way in a large proportion of electron tube circuits.

In order to change the two-element tube, or diode rectifier described in the foregoing, into an amplifier, it is necessary to add a third element, called a grid. The tube then becomes a triode which means three-element.

The grid consists of an open mesh, or spiral of fine wire placed between the cathode and the plate. Electrons travel from the cathode to the plate through the openings in the grid but this movement is controlled by the potential of the grid. If the grid is negative, this negative potential will repel some of the electrons and drive them back toward the cathode. Thus, fewer of them will be able to reach the plate and the plate current will be reduced. The greater the negative voltage on the grid, the lower the plate current. If the grid voltage is made more negative, a value will be reached such that no electrons can reach the plate and the plate current will be zero. This negative value of grid voltage is known as the cut-off bias and is shown in Fig. 13. (Note.—For explanation of abbreviations used in Fig. 13 and subsequent figures, see legend at end of this write-up.)

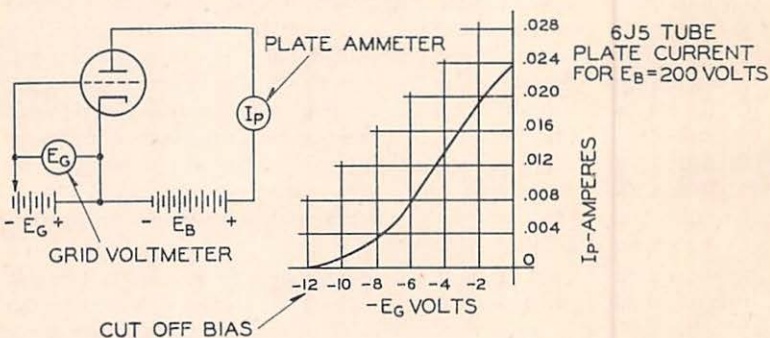


Fig. 13.

Grid Voltage Vs. Plate Current.

Conversely, if the grid voltage is made more positive (less negative), more electrons will reach the plate. Thus, the plate current will be increased. This phenomenon is shown in Fig. 13. The horizontal scale shows grid voltage measured from the cathode. The vertical scale shows plate current. The curve shows the value of plate current which flows when the plate voltage is held constant and the grid voltage is varied. This is one of the tube's characteristic curves and depends upon tube design. The curve shown is for a 6J5 triode with 200 volts on the plate.

Note that the grid voltage, Fig. 13, is shown negative. The relation between grid voltage and plate current, wherein the grid voltage is always negative, is very important in many amplifier and other tube applications. It was stated in the foregoing that the potential of the grid controls the movement of electrons from cathode to plate, as shown in Fig. 13. However, so long as the grid voltage is negative, no electrons can strike the grid because its negative po-

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tential repels the negatively charged electrons. That is, no current flows in the grid circuit so long as the grid voltage is negative. Since any device which prevents the flow of current when a voltage is applied to it must have very high resistance, it follows that the grid circuit of an electron tube has high resistance. Theoretically, it is infinite. Since no device is ever perfect, the grid resistance is finite, usually on the order of several million ohms. This fact is of great importance because it means that the grid extracts practically no power from the source used to drive it so long as the grid voltage does not become positive.

In Fig. 14, a transformer has been added in the grid circuit from which an AC voltage can be obtained, and a second transformer has been added in the plate circuit to deliver power to a load. A fixed grid battery of 4.5 volts is connected in series with the input transformer and a plate battery of 200 volts is connected in series with the output transformer. The grid battery fixes the direct current voltage on the grid which determines the value of direct current plate current, in this case 0.012 ampere. The grid battery voltage is known as bias, and the point OP as the operating point.

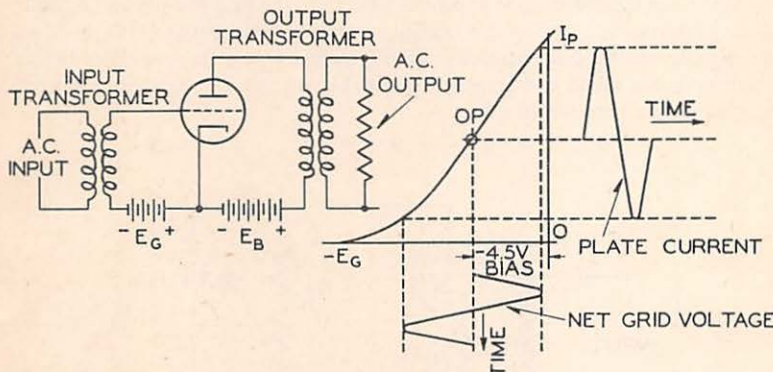


Fig. 14.

Plate Current Variations with an AC Voltage on Grid.

Assume that an AC voltage is supplied to the input transformer such that the net voltage at the grid, which is the sum of the AC voltage and the bias voltage, varies from minus 0.5 volt to minus 8.5 volts. In other words, the AC voltage has a value of 4 volts peak or 2.8 volts r.m.s. This AC grid voltage is shown superimposed on the bias voltage. When the net grid voltage is minus 0.5 volt, the plate current will increase to 0.022 ampere. When the net grid voltage is minus 8.5 volts, the plate current will decrease to 0.0025 ampere. The variation in plate current, which is an image of the grid voltage, is shown to the right in Fig. 14.

Assume that the output transformer has no losses, that its turn ratio is 1/1, and that a 7,000-ohm resistor is connected across the secondary. The varying plate current in the primary of the output transformer will induce a voltage across the load resistor which calculation will show to be about 50 volts, which is approximately 18 times greater than the input voltage. The tube is, therefore, operating as an amplifier with a voltage gain of 18.

It is often inconvenient to furnish a battery for the bias voltage, particularly if plate voltage is derived from a rectifier power supply. Recalling that element voltages are measured at the tube terminals and are referred to the cathode, a positive voltage applied to the cathode will produce the same bias as a negative voltage applied to the grid. Since the object is to stabilize the static conditions at point OP, bias can be obtained by using the plate current to develop a voltage across a suitable cathode resistor. The resistance of the cathode resistor is determined by dividing the required bias, 4.5 volts, by the desired current, 0.012 ampere, which is equal to 375 ohms.

For the sake of simplicity, a transformer coupled amplifier has been described in detail. A common type of amplifier is shown in Fig. 15, known as resistance coupled. In this circuit bias is developed by a cathode resistor R_C , input grid voltage is developed across a grid resistor R_G which usually has a high value, and the amplified output voltage is developed across a plate resistor R_L , the alternating current portion of which is taken off through a capacitor.

Any two adjacent conductors have electrostatic capacity between them. Thus, there is a small amount of capacity between the grid and plate of a triode tube. In some applications this capacity coupling from plate to grid produces undesirable results. A fourth element is often placed between the grid and plate which acts as a shield and greatly reduces the plate to grid capacity. Such a tube is called a screen grid tube.

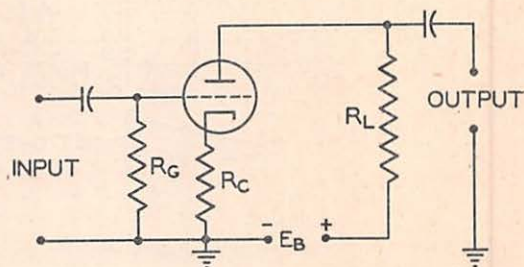


Fig. 15.
Resistance Coupled Triode Amplifier.

If the plate voltage is high, electrons in traveling from the cathode to the plate acquire very high velocities. They strike the plate like bullets and, in striking, dislodge additional electrons which cloud the area around the plate and disturb the proper flow of plate current. This phenomenon is known as secondary emission. To overcome secondary emission a fifth element, called a suppressor grid, is often placed close to the plate. The suppressor grid is usually connected to the cathode and therefore is negative with respect to the plate. Secondary electrons dislodged from the plate encounter the negative potential of the suppressor grid and are driven back to the plate. This is a very common type of tube known as a pentode. A resistance coupled pentode amplifier is shown in Fig. 16.

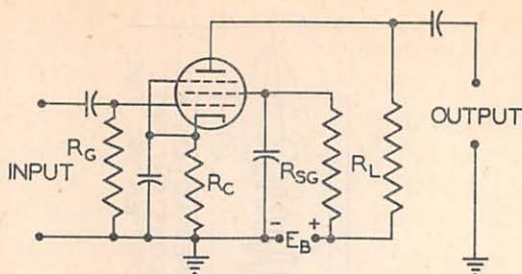


Fig. 16.
Resistance Coupled Pentode Amplifier.

Oscillator

For the purpose of this description, a high-vacuum^{*} class of tube with one or more grids will be considered.

An oscillation is any action which steadily repeats itself; for example, a cork on rippling water has an up-and-down or oscillating motion.

Consider a pendulum consisting of weight suspended on a string, as shown in Fig. 17. At rest, the weight hangs straight down at point O. Suppose the weight is moved to point A. To do this, the weight must be lifted against gravity and therefore a small amount of energy is transferred to the weight.

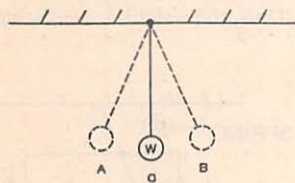


Fig. 17.
Simple Pendulum.

Now, suppose the applied force is suddenly removed. The weight will immediately start to swing down to O, and its momentum will carry it on to B, then back toward A, and so forth. The energy required to move the weight has been translated into motion of the weight. Each swing will be a little less than the last, because a small amount of energy is lost each time in air resistance and flexing the string. Eventually, the weight will come to rest at O when all the energy originally supplied has been dissipated. The weight is oscillating with what is known as "damped" oscillation. The term means that one unit of energy was supplied, and then the oscillation was allowed to decrease to zero.

Assume that a pen, Fig. 18, is mounted on the weight and that the pen marks a strip of paper. Assume also that the paper is moved vertically at a steady rate: for example, one inch per second. Distance along the paper then represents time: two inches, two seconds; ten inches, ten seconds; and so on. The line drawn by the pen on the moving paper will be a graph of the damped oscillations of the weight, the swings becoming less and less until the weight comes again to rest.

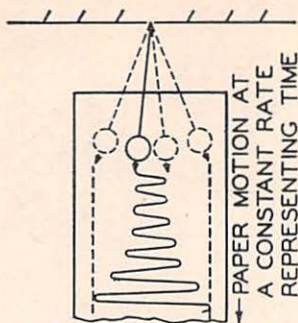


Fig. 18.
Graph of a Pendulum Swinging with Damped Oscillation.

To go a step further, suppose a source of energy in the form of a coil spring is added and machinery provided so that a small amount of this stored energy is applied to the weight on each swing, this application so adjusted that it is enough to make up the losses in the system. Under these conditions, the weight will swing with what is called "sustained" oscillation.

A graph of these sustained oscillations will be as shown in Fig. 19 and is similar to the sine wave referred to in alternating current electricity. Since the losses in the system are made up from the energy source, each swing is the same as the preceding swing. Thus, the weight is oscillating with what is known as constant amplitude.

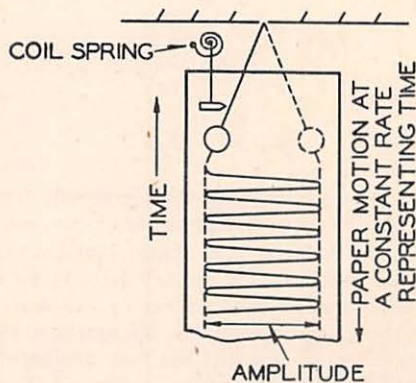


Fig. 19.
Graph of a Pendulum Swinging with Sustained Oscillation.

The graph, Fig. 19, not only shows how far the weight swings back and forth, that is, its amplitude, but also how fast it swings, or its frequency. The paper was assumed to be moving at the steady rate of one inch per second. If one inch of paper includes two complete traces, then the frequency of oscillation is two cycles per second. If there are 1,000 complete traces, the frequency is 1,000 cycles per second.

Returning to the source of energy which keeps the weight swinging, observe this very important requirement. Energy must be applied so as to help the weight in its swing and not to hinder it; that is, "in phase" with the swing. If the application is "out of phase," or opposing the swing, the oscillation will be stopped.

The action of the mechanical system has been described in detail, because it is familiar and because it closely resembles the electrical action of an electron tube oscillator.

Consider the electrical circuit of Fig. 20, consisting of a coil whose symbol is L , a capacitor whose symbol is C , a battery, and a key. With the key down, and the capacitor connected as shown, current flows into the capacitor until enough electrons have collected on its plates to make the voltage between the plates equal to the battery voltage. The flow of electrons then stops and the capacitor is said to be charged. This is equivalent to the act, in the mechanical analogy, of moving the weight from its idle position O to position A in Fig. 17. As long as the key is closed down, in Fig. 20, or the weight is held at A , in Fig. 17, nothing else happens.

Now, assume the circuit of Fig. 20 is modified, as shown in Fig. 21, to include a device equivalent to the pen and paper used in the mechanical system, which will show the motion of electrons or electric current. For low frequencies, this device could be a magnetic oscillograph, which makes a visible trace of electric current on photographic film; or for high frequencies a cathode-ray oscillograph, which makes a visible trace on a special electron tube called a cathode-ray tube. Move the key up so that the capacitor is connected to the coil. In the mechanical analogy, this is equivalent to releasing the weight at A and allowing it to swing toward O (Fig. 17). In Fig. 21, the electrons on the negative plate of the capacitor now find a metallic path along which they can travel, attracted by the positive charge on the positive plate. That is, a movement of electrons takes place as shown by the solid arrow. This is an electric current which flows through the coil.

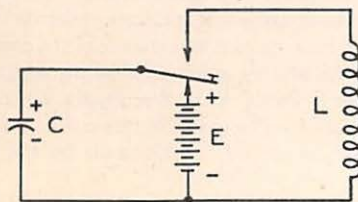


Fig. 20.

A Capacitor Charged from a Battery.

Another phenomenon now occurs which is similar to the mechanical case. The weight, when at rest, tends to oppose any attempt to move it. This is called inertia. It takes power or energy to move the weight. However, once some energy has been used to get the weight moving, it tries to oppose any attempt to stop it and tends to keep moving. This characteristic is called "momentum."

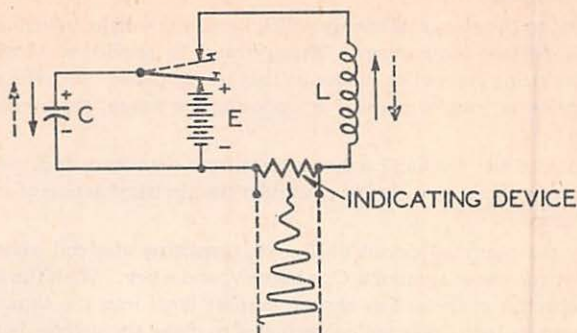


Fig. 21.

Graph of Damped Oscillations in a Coil and Capacitor.

A coil is approximately the electrical equivalent of the weight. The coil has electrical inertia in that it tends to oppose an increase in current through it. Once energy has been used to start current flowing, the coil has electrical momentum which tries to keep the current flowing.

The result, in Fig. 21, is that once the energy stored in the capacitor has forced current to flow in the coil, the electrical momentum of the coil keeps the current flowing, so that instead of just enough electrons flowing to the upper plate to cancel the positive charge, almost all the electrons flow to the upper plate and it becomes negatively charged to a value nearly equal to the previous positive charge. Once this condition is reached, the coil has used up all its stored energy or electrical momentum and the current becomes zero; but the system is unbalanced because the capacitor still has a charge, though of the opposite polarity. The instant the current falls to zero the electrons now on the upper plate are attracted by the charge on the lower plate and start to travel back through the coil in the opposite direction. Thus, a current again flows, but in the opposite direction. Again the coil tries to keep the current flowing until the lower plate has collected almost all the electrons.

This flow of current back and forth is electrical oscillation. It is "damped" oscillation because each time current flows, some of the energy originally stored in the capacitor from the battery is lost in heat through the resistance of the circuit, which can never be made zero. Eventually, all the energy will be lost and the oscillation will stop. The graph of this current, as shown by the indicating device in Fig. 21, is similar to that made by the damped mechanical oscillations of Fig. 18.

In Figs. 17 and 18, the amplitude of swing is determined by the distance the weight is moved away from O. The frequency of its swing is determined largely by the length of the string.

In Fig. 21, the amplitude of electrical oscillation is determined by the voltage of battery E; that is, how far electrically the charge on the capacitor is moved to one side. The frequency of oscillation is determined by the inductance of the coil and the size of the capacitor.

The formula for obtaining the frequency of a coil and capacitor combination to a very close approximation is:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$(LC)^{1/2}$

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Where f is the frequency in cycles per second, L the inductance in henries and C the capacity in farads. The constant π is equal to 3.1416. The unit of capacity, a farad, is very large. Therefore, the usual unit is a microfarad, which is one-millionth of a farad, designated as mfd. In calculations, however, it must be remembered that 1.0 mfd is actually one farad divided by one million.

In Fig. 22, an electron tube has been added to the circuit of Fig. 21, and the indicating device, or the load to which alternating current is to be supplied, has been moved to the plate circuit. With the tube functioning as an amplifier, the voltage generated by the oscillating current through L and C will vary the voltage on the grid, and this in turn will vary the plate current. Plate current variations will follow the grid voltage variations, which will develop a voltage across the resistor R_L and the load. Variations across the load will be larger than the variations across the coil and capacitor, because the tube is functioning as an amplifier.

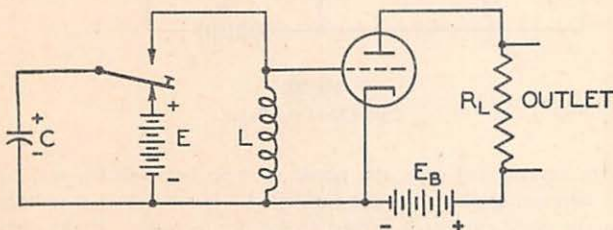


Fig. 22.

Coil and Capacitor Followed by an Amplifier.

So far, an electrical circuit has been developed to the point where damped oscillations are produced and amplified. The next step is to provide the electrical equivalent of the mechanical energy furnished by the coil spring in the mechanical analogy so that sustained oscillations can be produced.

In Fig. 23, the battery across the capacitor has been removed, and a second coil has been added in the plate circuit. This second coil or its equivalent (many circuits do a similar thing in other ways) is very important. It provides the additional energy to sustain oscillation. The second coil L_P , which will be referred to as the plate coil, is inductively coupled to the grid coil L_G . The action of the two together is exactly the same as that in a power transformer where a current in either coil induces a voltage in the other coil. Assuming for the moment that oscillations have been started, at any instant the voltage at G is either becoming more positive or more negative because of the oscillating current circulating in L_G and C . Assume the direction is first as shown by the solid arrow and G is becoming more positive. As the grid becomes more positive, more plate current will flow through plate coil L_P . Since L_P is coupled to L_G , this increasing plate current will induce still more voltage in L_G . Eventually, a point will be reached where all the electrons which the cathode can emit are attracted to the plate and the plate current cannot increase further. The tube is then said to be saturated. Thus, the voltage induced in L_G from L_P will fall to zero. But, in the process, capacitor C will be left with a charge, which immediately causes a current to flow back through L_G and the voltage

at G becomes more negative. As the grid voltage becomes more negative, the plate current decreases. This decrease in plate current through L_P induces still more negative voltage in L_G . Eventually, the grid will become so negative that no current can flow and, therefore, the plate current will become zero. This condition finds C again charged, but with opposite polarity, and the cycle repeats itself.

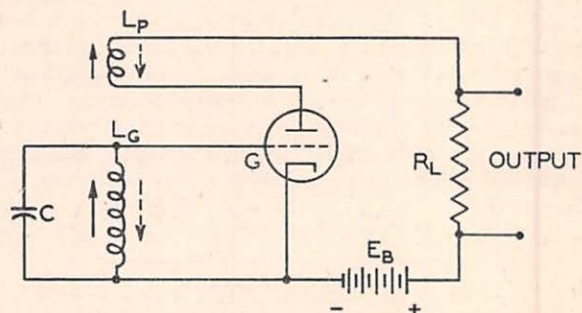


Fig. 23.
Tuned Grid Oscillator.

As in the mechanical case, the phase relation between L_G and L_P is important. Increasing plate current through L_P must induce a voltage in L_G such that the plate current is caused to further increase. If the direction of current through L_P is reversed by reversing the leads which reverse the phase relation, the circuit will not oscillate.

Energy to overcome losses in the circuit, and to deliver power to the load comes from the plate battery E_B .

It was assumed in the preceding paragraphs that the circuit was oscillating. The sudden application of power is adequate to start oscillation. The frequency of oscillation is largely determined by the values of L_G and C , and power output is determined by the choice of tube, plate supply voltage, and so forth. Power can be taken directly from the oscillator, or it can be followed by other tubes to increase power.

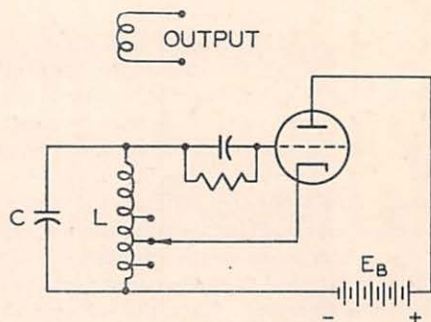


Fig. 24.
Hartley Oscillator.

The circuit shown is known as a tuned grid oscillator. The capacitor could be connected across L_P and it would become a tuned plate oscillator. Or two capacitors could be used, one across L_P and one across L_G , and it would be a tuned grid-tuned plate oscillator. A common type shown in Fig. 24 is called a Hartley oscillator. In this circuit, the functions of L_P and L_G are combined in one coil with the cathode connected to a tap on the coil.

Modulator

Modulation is the action of one force on another. There are several types of modulation: for example, frequency modulation, phase modulation, and amplitude modulation. In communication, the modulation is that part of the transmitted energy which contains the intelligence. This description will be confined to amplitude modulation.

Suppose an oscillator such as that described in the foregoing text is put in operation and its output connected across a pair of wires. Then suppose it is found that some distance away the oscillating voltage appears between the wires. This steady voltage would serve no useful purpose as long as it is unmodulated. However, if the oscillator is equipped with a telegraph key in the plate circuit so that oscillations can be started or stopped at will, and an amplifier at the other end is equipped with a sounder, the combination becomes a "carrier" telegraph circuit. The starting and stopping of oscillations is the modulation and contains the telegraphic intelligence. An example of this is shown in Fig. 25 and is the simplest form of modulator.

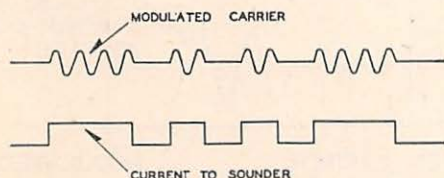


Fig. 25.

On-Off Modulation Applied to a Carrier.

In the telegraph example, the oscillator is either oscillating or not oscillating. The oscillator can also be modulated by making its output larger or smaller.

In Fig. 26 an addition has been made to the oscillator circuit which includes a carbon microphone, a small battery, and a microphone transformer. This circuit contains two examples of modulation. Speaking into the microphone agitates the carbon granules in the microphone, which changes the resistance of the circuit. This change in resistance varies or modulates the flow of current from the microphone battery through the primary of the microphone transformer. Variations in the primary current appear at the transformer secondary as an alternating current voltage whose amplitude and frequency are determined by the amplitude and frequency of the voice tones.

Under the heading "Oscillator," it was stated that the output of an oscillator depends, among other things, upon the voltage of the plate battery. In the present case, an AC voltage from the microphone is added to the DC plate

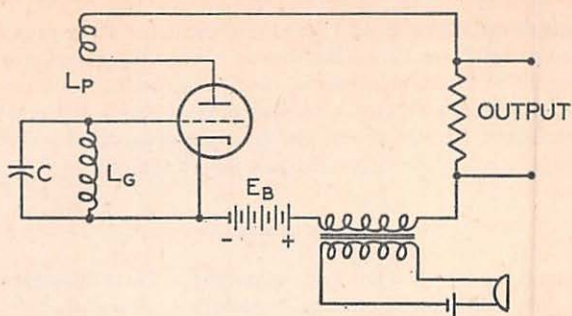


Fig. 26.
Circuit for Voice Modulating a Tuned Grid Oscillator.

voltage," which on positive half cycles will increase the total plate voltage and on negative half cycles decrease the total plate voltage. Thus, the output of the oscillator at any instant will be more or less than average, depending upon the voice tones.

This action is illustrated in Fig. 27. If the plate battery is 100 volts and the alternating current from the microphone has a peak value of 50 volts, the plate voltage will then vary as shown in Fig. 27-a and oscillator output will vary as shown in Fig. 27-b. The shape of the carrier wave which is a curved line drawn through successive peaks of the carrier is the modulation.

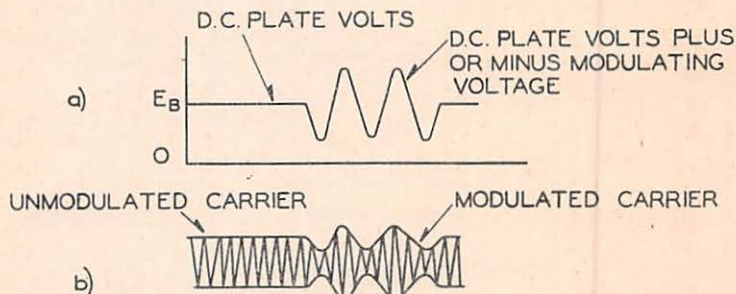


Fig. 27.
Sine Wave Modulation Applied to a Carrier.

The term "carrier" (referred to above) is used to designate the alternating current wave that is modulated. It carries with it the intelligence in the form of modulation.

An example of an electron tube, used as a modulator, is shown in Fig. 28. The oscillator can be any of the types described under the heading "Oscillator," and the general form of the carrier amplifier has been described under the heading "Amplifier." The tube used as a modulator is one application of a tube as an amplifier. The small voltage from the microphone is amplified, and the amplified voltage is applied in series with the direct current plate supply to the carrier amplifier. The result is a variation in total plate voltage to the carrier amplifier, and therefore a variation in the amplitude of the carrier, as shown in Fig. 27.

The system in Figs. 26, 27 and 28 is known as plate modulation because the plate voltage is varied by the voice tones. The modulating voltage can be applied to other elements of the carrier amplifier: for example, the grid. In this case, the system is known as grid modulation. When a tube with more than one grid is used in the carrier amplifier, the modulating voltage can be applied to any grid.

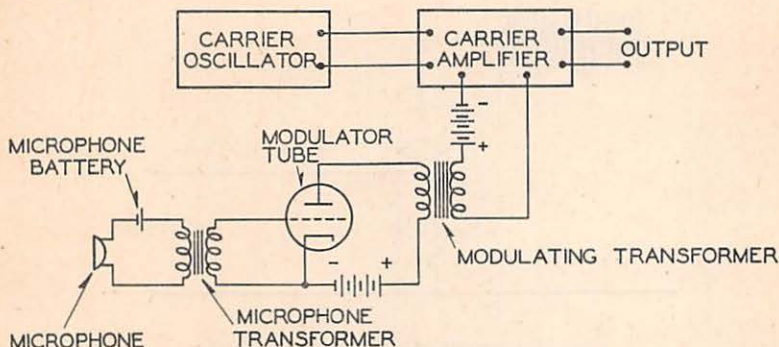


Fig. 28.
Triode Tube Used as a Modulator

Detector or Demodulator

The intelligence carried by a carrier wave is of no use until it has been recovered at the receiving end. The recovery is known as detection or demodulation and, as the name indicates, is the reverse of modulation.

The simplest form of detector, and one widely used in communication equipment, is a rectifier, usually an electron tube rectifier.

A rectifier or two-element tube used as a detector is shown in Fig. 29. Recalling from the text under the heading "Rectifier," that a rectifier will pass current freely in one direction but blocks it in the opposite direction, it will be seen that the current through resistor R_C and, therefore, the voltage across R_C is a series of half-wave peaks which is an image of one-half of the modulated carrier. The intelligence is contained in the shape of the rectified peaks. It is desirable to recover only the variation in the carrier voltage in order to separate the carrier from the voice tones.

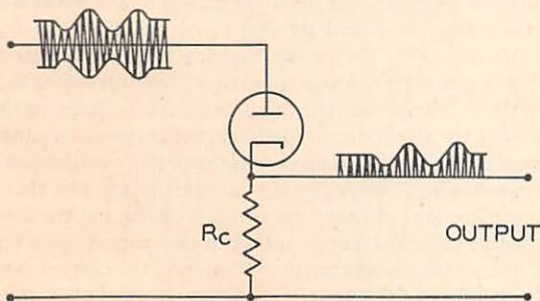


Fig. 29.
Diode Used as a Detector.

If the carrier frequency is much higher than the modulating frequency, this separation can be easily obtained by adding a capacitor of the proper value across R_C , as shown in Fig. 30. This capacitor will by-pass or shunt the carrier and leave only the desired intelligence in the output. This is the most commonly used type of detector or demodulator for amplitude modulated carriers.

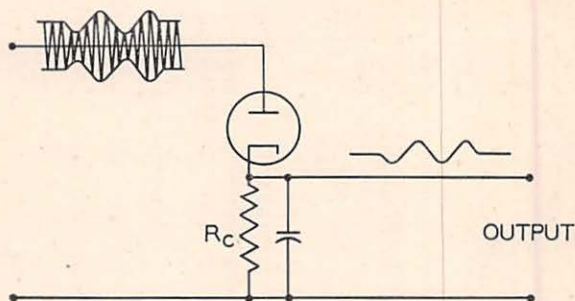


Fig. 30.
Diode Detector with a Capacitor to Shunt Carrier.

ELECTRIC WAVE FILTER

An electric wave filter is a combination of electrical impedances (usually impedance coils and capacitors) arranged to allow alternating currents of certain frequencies to pass with little or no loss while currents of other frequencies are greatly reduced: for example, see Fig. 31.

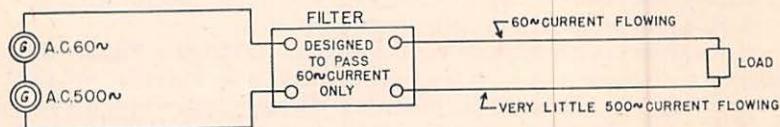


Fig. 31.
Function of Electric Wave Filter.

To explain how a filter operates, it is necessary to know how a capacitor and inductance (impedance coil) affect electrical current in an electrical circuit.

If two metal plates are placed parallel to one another and separated by insulation as shown in Fig. 32, the combination is capable of storing electric energy. Such a device is known as a "capacitor." When switch S_1 , in Fig. 32, is first closed, the maximum current flows, but as the voltage on the capacitor increases, opposing the voltage on the battery, the current is gradually reduced until the voltage across the capacitor equals the battery voltage, at which time the current stops flowing. Attention is also called to the fact that no voltage is across the capacitor at the instant the switch is closed, but the flow of current is maximum at this time. At the instant when the current stops flowing, or is equal to zero, the voltage is maximum. Therefore, the current is said to lead the voltage by 90 degrees. After the capacitor is charged, if the battery is removed from the circuit and switch S_1 (Fig. 33) is closed, the current will flow through the resistor until the capacitor is discharged. This current will be

maximum at the instant the switch is closed, and will gradually reduce until no voltage remains across the capacitor to cause a flow of current.

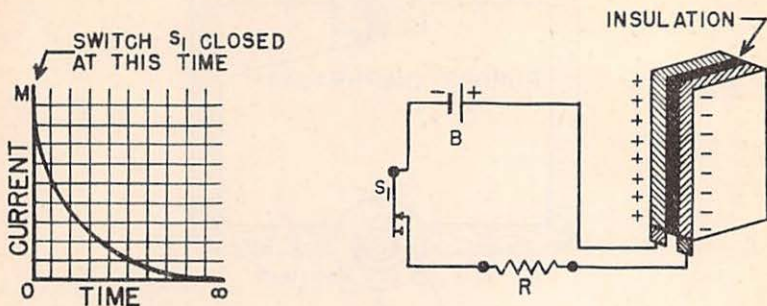


Fig. 32.
Effect of Capacitor on Electric Current.

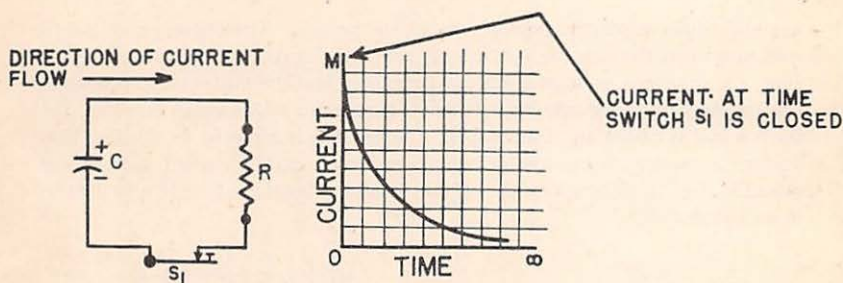


Fig. 33.
Discharge of Electric Current in Capacitor.

In order to explain how alternating current flows through a capacitor, a hydraulic analogy is shown in Fig. 34, which corresponds to the electrical circuit shown in Fig. 32. Like the electrical circuit, when the pump initially starts, the greatest quantity of water flows, but as the rubber diaphragm is stretched, the pressure of the diaphragm opposes the pressure of the pump and the flow of water is gradually stopped. It will stop when diaphragm pressure and the opposing pressure of the pump are equal.

It can be readily seen that if the pump is operated in the opposite direction the water will flow in the opposite direction until it is stopped by the rubber diaphragm. If the water is pumped first in one direction and then in the other direction, water will flow to and fro in the circuit. This latter statement explains how alternating current flows in a circuit which contains a capacitor.

If sufficient wire is wrapped around a cylindrical tube providing several turns (see Fig. 35), and a battery is connected to the ends of the coil of wire, a magnetic field is created by the flow of current. This magnetic field building up causes a voltage to be generated in the coil which opposes the battery volt-

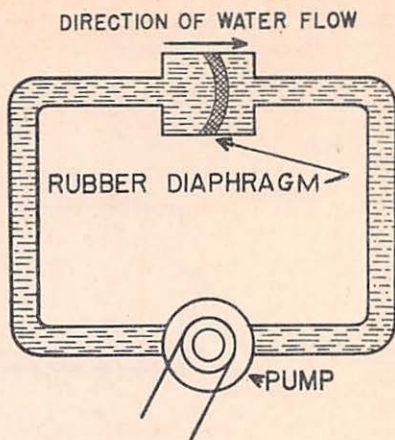


Fig. 34.
Hydraulic Analogy of a Capacitor.

age and thus retards the flow of current in the coil. The opposing voltage is maximum and the current is minimum when the circuit is first closed. However, the opposing voltage gradually decreases and the current increases proportionately until the current reaches its maximum stable value (see Fig. 35). Such a coil is called an "inductance." Attention is directed to the fact that voltage is maximum but the current is minimum at the instant switch S_1 is closed in Fig. 35. Therefore, the current is said to lag the voltage by 90 degrees in an inductance.

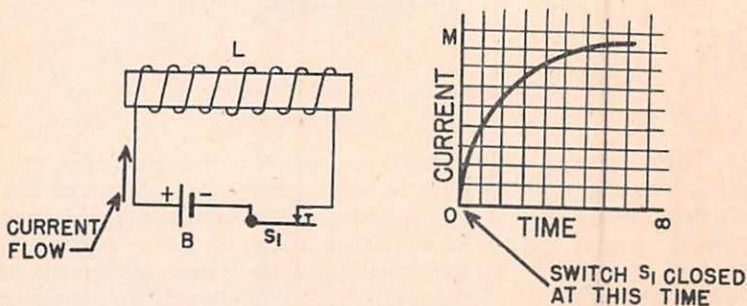
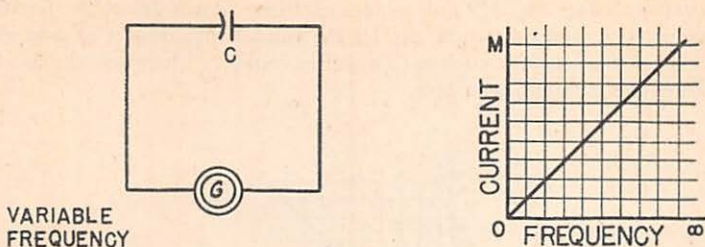


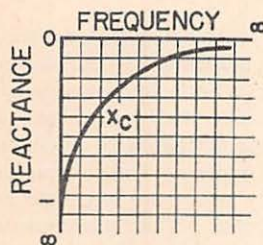
Fig. 35.
Effect of Inductance on Electric Circuit.

From the foregoing it is evident that direct current will not flow through a capacitor after the capacitor becomes charged. However, if an alternating current generator is applied to the circuit as shown in Fig. 36, current will flow. Thus, assuming that a direct current is an alternating current of zero frequency, it is evident that the alternating current in the circuit of Fig. 36 increases as the frequency increases provided the voltage of the generator remains constant.

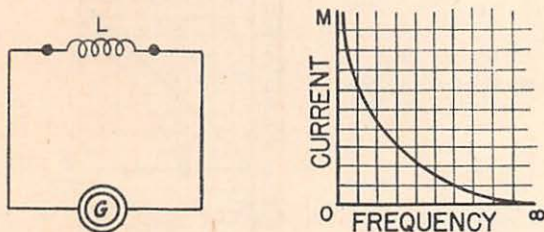
Fig. 36.
Reactance.

The ability of a capacitor to stop the flow of a direct current and reduce the flow of an alternating current is called "reactance."

Figure 37 shows how the reactance of a capacitor varies with the frequency of an alternating current.

Fig. 37.
Reactance.

From the explanation of an inductance, it is evident that the current through an inductance is zero if the frequency is infinite. If the frequency is reduced, the current will increase (as shown in Fig. 38), provided the voltage of the generator remains constant.

Fig. 38.
Effect of Reactance on Alternating Current.

If this ability of an inductance to reduce the flow of an alternating current is called reactance, then Fig. 39 shows how the reactance of an inductance varies with the frequency of an alternating current. It will be noted that the reactance of an inductance (see Fig. 39) is shown as positive while the reactance

of a capacitor (see Fig. 37) is shown as negative. This is due to the fact that an inductance causes the current to lag the voltage with respect to time while the capacitor causes the current to lead the voltage. Therefore, the two are opposite and have opposite signs.

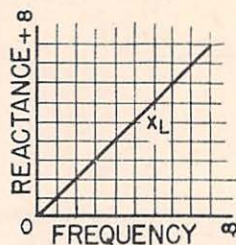


Fig. 39.

Reactance Effect of an Inductance with Frequency on Alternating Current.

In Fig. 40, a circuit with resistance, inductance and a capacitor connected in series is shown. The graph illustrates how the reactance of the inductance X_L and of the capacitor X_C varies as the frequency is changed. The dotted curve X_{LC} is the combined reactance of the circuit and is equal to the difference (algebraic sum) between the reactances of the inductance and capacitance. It will be noted that at one frequency, and only one, designated as F_R the positive reactance caused by the inductance equals the negative reactance caused by the capacitor in the circuit. When this occurs the reactances of the inductance and the capacitor cancel out and the circuit is said to be "resonant." At this frequency F_R the resistance of the circuit and the voltage of the generator determine the amount of current that will flow. If the frequency is raised or lowered, the current will reduce due to the effect of the combined reactance X_{LC} increasing either positive or negative.

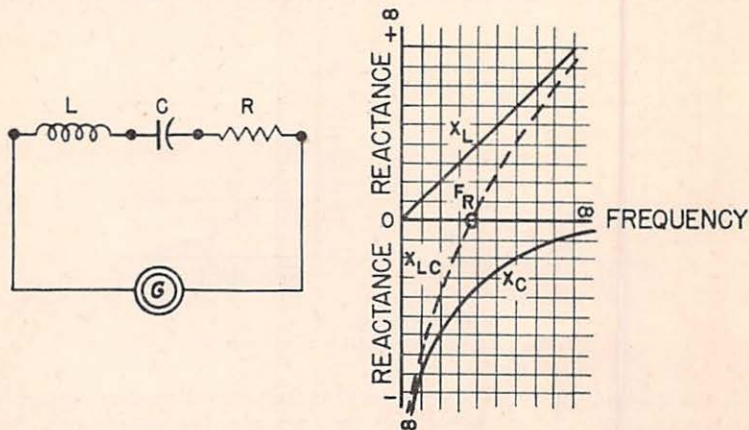
Fig. 40.
Resonance.

Figure 41 illustrates how the current varies in a series circuit containing resistance, inductance and capacity as the frequency is changed from zero to infinity. It will be noted that the current is maximum at the resonant point F_R .

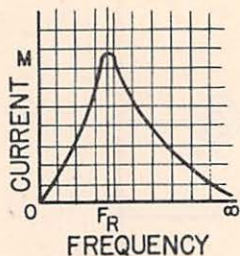


Fig. 41.
Effect of Resonance on Electric Current.

If an inductance and capacitor are connected in parallel, as shown in Fig. 42, the circuit is said to be "anti-resonant" when the positive reactance of the inductance and the negative reactance of the capacitor are equal. The total reactance of the circuit is infinite at the frequency F_R at which anti-resonance occurs as can be seen by the dotted lines X_{LC} shown in the graph of Fig. 42.

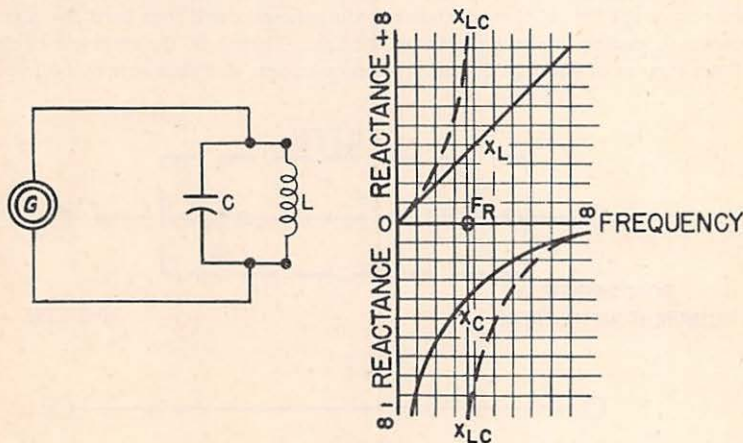


Fig. 42.
Anti-Resonance.

In Fig. 43 a circuit with resistance in series with an inductance is shown in parallel with a capacitor. The graph illustrates how the voltage varies across the capacitor as the frequency is changed. It will be noted that the voltage across an anti-resonant circuit varies in a similar manner as the current in a series resonant circuit. However, for comparison, it should be pointed out that in a parallel circuit (Fig. 43), the current is minimum at the frequency F_R where anti-resonance occurs, while the current is maximum in a series circuit (Fig. 41) at the frequency F_R where anti-resonance occurs, while the current

is maximum in a series circuit (Fig. 41) at the frequency F_R where resonance occurs.

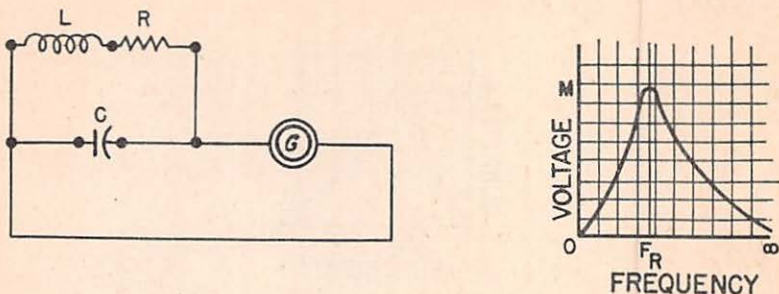


Fig. 43.
Anti-Resonance Effect on Voltage.

In Fig. 44 a series resonant circuit is shown connected between a carrier current generator or an alternating current source and the line. This resonant circuit is tuned to the desired frequency so that the current of this frequency will be greater than the current of any undesired frequencies in the circuit. If currents of any other frequencies are present on the line, the resonant circuit will reduce the flow of these currents to the generator and thus keep the generator from loading or short circuiting the line. Therefore, the resonant circuit allows current of only the desired frequency to pass and thus acts as a filter.

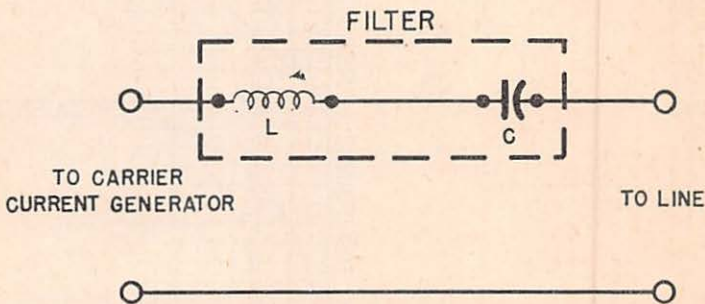


Fig. 44.
Resonant Circuit.

In Fig. 45 a parallel anti-resonant circuit is shown connected between an amplifier and the line. The secondary side of the transformer acts as the inductance in this circuit. The anti-resonant circuit is tuned to the desired frequency so that the voltage of this frequency will be much greater than the voltage of any other carrier currents of other frequencies present on the line. In view of the fact that the voltage which is applied to the amplifier is much greater at the desired frequency, the output of the amplifier will likewise be higher at the desired frequency, and thus an anti-resonant circuit serves to filter out unwanted voltages of other frequencies.

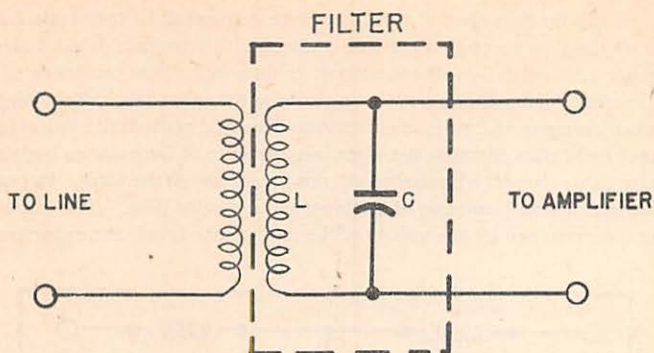


Fig. 45.
Anti-Resonant Circuit.

Figure 46 shows a four-terminal network with capacitors connected between terminals 1 and 3, and an inductance connected between the mid-point of the two capacitors and terminals 2 and 4. This network is known as a high-pass filter. It can readily be seen that if a battery were connected across terminals 1 and 2 and with a resistance connecting 3 and 4, no current would flow since previous study has shown that direct current will not flow through a capacitor. However, if an alternating current is connected to terminals 1 and 2 and the frequency of this current is sufficiently high as to be above the cut-off frequency, this alternating current will pass into a resistor connected across 3 and 4 with very little loss. If an alternating current generator with frequency lower than the cut-off frequency is connected to terminals 1 and 2, no current, or practically none, will flow into a resistor connected to terminals 3 and 4. Therefore, all currents of frequencies between zero and some finite value (cut-off frequency) will not flow through these filters. All currents of frequencies above this finite value (cut-off frequency) will flow through the filters. The cut-off frequency is determined by the values of the inductance L and the capacitor C .

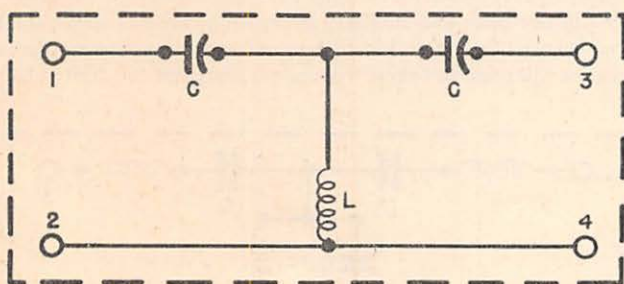


Fig. 46.
High-Pass Filter.

Figure 47 shows a four-terminal network with inductances connected in series between terminals 1 and 3. A capacitor is connected between the two inductances and terminals 2 and 4. This network is known as a low-pass filter.

It can readily be seen that if a battery were connected to terminals 1 and 2, current would flow through a resistor connected to terminals 3 and 4 since the inductance coils will allow direct current to flow, but offers reactance to alternating current. This filter reacts in an opposite manner to that of the high-pass filter since currents of frequencies between zero and some finite value (cut-off frequency) will pass through the filter but currents of frequencies higher than this finite value (cut-off frequency) will not pass through the filter. In practical applications, a small amount of current will actually pass. The cut-off frequency is determined by the values of the inductance L and the capacitor C .

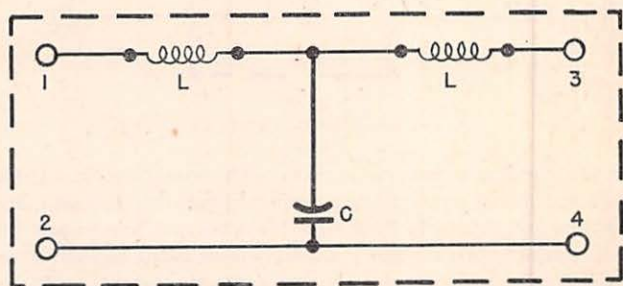


Fig. 47.
Low-Pass Filter.

Figure 48 shows a four-terminal network that is known as a band pass filter. It will be noted that both capacitors and inductances are in series between terminals 1 and 3 and an anti-resonant circuit is connected between the capacitors and terminals 2 and 4. It can readily be seen that no direct current can flow through the circuit, and that, in view of the fact that with an inductance in the series portion of the circuit very little alternating current of very high frequency can pass. Therefore, these filters can be designed so as to pass alternating current above a certain cut-off frequency and below another cut-off frequency. Alternating currents of frequencies below the lower cut-off frequency will not pass, and similarly alternating currents above the highest cut-off frequency will not pass, but current of frequencies between the two cut-off frequencies will pass, and these frequencies represent the desired band.

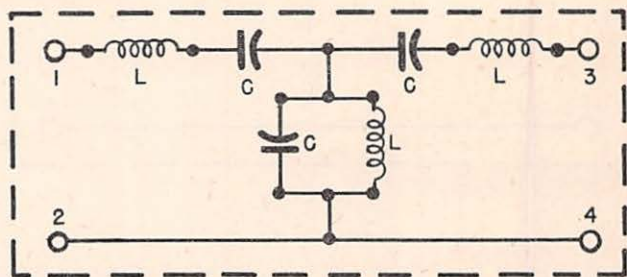


Fig. 48.
Band Pass Filter.

Figure 49 shows a four-terminal network with anti-resonant circuits between terminals 1 and 3, and a series resonant circuit connected between mid-point of the anti-resonant circuit and terminals 2 and 4. This circuit will act as a band elimination filter; that is, it will allow alternating currents from zero up to a particular finite frequency (lowest cut-off frequency) to pass, then retard alternating current between this frequency and a higher finite frequency (highest cut-off frequency), and then allow alternating currents of frequencies above this highest cut-off frequency to pass.

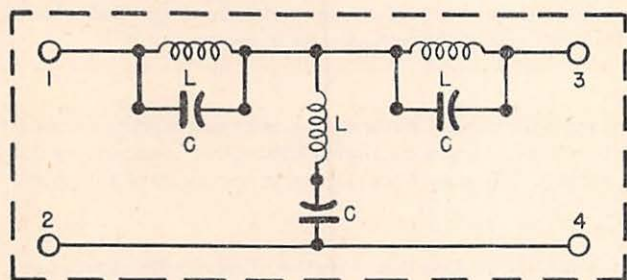


Fig. 49.
Band Elimination Filter.

Additional information supplementing the foregoing will be presented as it becomes available.

LEGEND

- M = Maximum
- ∞ = Infinity
- X_L = Inductive reactance
- X_C = Capacitive reactance
- X_{LC} = Combined reactance
- F_R = Resonant frequency
- L = Coil (inductance)
- C = Capacitor (capacitance)
- R = Resistance
- S_i = Knife switch S.P.S.T.
- $\sim$ = Cycle
- $\textcircled{G}$ = A.C. source
- B = Battery
- E_G = Grid voltage
- I_P = Plate current
- E_B = Plate supply voltage
- R_G = Grid resistor
- R_C = Cathode resistor
- R_{SG} = Screen grid resistor
- R_L = Plate load resistor
- L_G = Grid inductance
- L_P = Plate inductance

Action Recommended

Acceptance as information.

ELECTRONIC TERMS AND SYMBOLS USED IN SIGNALING*

1949

*General**Electronics.*

Electronics is that branch of science and technology which relates to the conduction of electricity through gases or in vacuo.

Electron.

An electron is the natural, elementary quantity of negative electricity. The quantity of electricity on an electron is 1.592×10^{-19} coulomb, or 4.774×10^{-10} electrostatic unit. The mass of an electron at rest is 9.00×10^{-28} gram.

Ion.

An ion is an electrified portion of matter of subatomic, atomic or molecular dimensions.

Electrode.

An electrode is a conductor belonging to the class of metallic conductors, but not necessarily a metal, through which a current enters or leaves an electrolytic cell, arc, furnace, vacuum tube, gaseous discharge tube, or any conductor of the non-metallic class. Specifically, in an electrolytic cell, an electrode is a conductor of the metallic-conductor class, at which there is a change from conduction by electrons to conduction by ions or colloidal particles.

Electron emission.

Electron emission is the liberation of electrons from an electrode into the surrounding space. Quantitatively, it is the rate at which electrons are emitted from an electrode.

Thermionic emission. (Edison Effect) (Richardson Effect)

Thermionic emission is electron or ion emission due directly to the temperature of the emitter. Electrons are emitted from hot bodies, the rate of emission increasing rapidly with temperature.

Secondary emission.

Secondary emission is electron emission due directly to the impact of electrons or ions.

Ionization.

Ionization is the process of producing ions.

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Ionization current.

Ionization current is the electric current resulting from the movement of electric charges in an ionized medium, under the influence of an applied electric field.

Gas current.

Gas current is a current flowing to an electrode and composed of positive ions which have been produced as a result of gas ionization by an electron current flowing between other electrodes.

*Vacuum Tubes**Vacuum tube.*

A vacuum tube is a device consisting of an evacuated enclosure containing a number of electrodes between two or more of which conduction of electricity through the vacuum or contained gas may take place.

High-vacuum tube. (Electron tube)

A high-vacuum tube is a vacuum tube evacuated to such a degree that its electrical characteristics are essentially unaffected by gaseous ionization.

Thermionic tube.

A thermionic tube is a vacuum tube in which one of the electrodes is heated for the purpose of causing electron or ion emission from that electrode.

Gas tube.

A gas tube is a vacuum tube in which the pressure of the contained gas or vapor is such as to affect substantially the electrical characteristics of the tube.

Mercury-vapor tube.

A mercury-vapor tube is a gas tube in which the active contained gas is mercury vapor.

Phototube. (Photoelectric tube)

A phototube is a vacuum tube in which one of the electrodes is irradiated for the purpose of causing electron emission from that electrode.

Cathode-ray oscillograph tube.

A cathode-ray oscillograph tube is a vacuum tube in which the deflection of an electron beam, effected by means of applied electric and/or magnetic fields, indicates the instantaneous values of the actuating voltages and/or currents.

Diode.

A diode is a two-electrode vacuum tube containing an anode and a cathode.

Triode.

A triode is a three-electrode vacuum tube containing an anode, a cathode and a control electrode.

Tetrode.

A tetrode is a four-electrode vacuum tube containing an anode, a cathode, a control electrode and one additional electrode ordinarily in the nature of a grid.

Pentode.

A pentode is a five-electrode vacuum tube containing an anode, a cathode, a control electrode and two additional electrodes ordinarily in the nature of grids.

Hexode.

A hexode is a six-electrode vacuum tube containing an anode, a cathode, a control electrode and three additional electrodes ordinarily in the nature of grids.

Heptode.

A heptode is a seven-electrode vacuum tube containing an anode, a cathode, a control electrode and four additional electrodes ordinarily in the nature of grids.

Octode.

An octode is an eight-electrode vacuum tube containing an anode, a cathode, a control electrode and five additional electrodes ordinarily in the nature of grids.

Multiple-unit tube.

A multiple-unit tube is a vacuum tube containing within one envelope two or more groups of electrodes associated with independent electron streams.

Note.—A multiple-unit tube may be so indicated, as, for example: duodiode, duotriode, diode-pentode, duodiode-triode, duodiode-pentode and triode-pentode.

*Vacuum Tube Electrodes**Anode (of a vacuum tube). (Plate)*

An anode of a vacuum tube is an electrode to which a principal electron stream flows.

Plate.

Plate is a common name for the principal anode in a vacuum tube.

Cathode (of a vacuum tube).

A cathode of a vacuum tube is an electrode which is the primary source of an electron stream.

Indirectly heated cathode. (Equipotential cathode) (Unipotential cathode)

An indirectly heated cathode is a cathode of a thermionic tube to which heat is supplied by an independent heater element.

Heater.

A heater is an electric heating element for supplying heat to an indirectly heated cathode.

Filament.

A filament is a cathode of a thermionic tube, usually in the form of a wire or ribbon, to which heat may be supplied by passing current through it.

Control electrode.

A control electrode is an electrode on which a voltage is impressed to vary the current flowing between two or more other electrodes.

Grid.

A grid is an electrode having one or more openings for the passage of electrons or ions.

Control grid.

A control grid is a grid, ordinarily placed between the cathode and an anode, for use as a control electrode.

Screen grid.

A screen grid is a grid placed between a control grid and an anode, and usually maintained at a fixed positive potential; for the purpose of reducing the electrostatic influence of the anode in the space between the screen grid and the cathode.

Space-charge grid.

A space-charge grid is a grid which is placed adjacent to the cathode and positively biased so as to reduce the limiting effect of space charge on the current through the tube.

Suppressor grid.

A suppressor grid is a grid which is interposed between two electrodes (usually the screen grid and plate), both positive with respect to the cathode, in order to prevent the passing of secondary electrons from one to the other.

*Electrode Voltage, Current and Power**Electrode voltage.*

Electrode voltage is the voltage between an electrode and a specified point of the cathode.

Anode voltage.

See Electrode voltage.

Peak (or crest) forward anode voltage.

Peak (or crest) forward anode voltage is the maximum instantaneous anode voltage in the direction in which the tube is designed to pass current.

Peak (or crest) inverse anode voltage.

Peak (or crest) inverse anode voltage is the maximum instantaneous anode voltage in the direction opposite to that in which the tube is designed to pass current.

Heater voltage.

Heater voltage is the voltage between the terminals of a heater.

Filament voltage.

Filament voltage is the voltage between the terminals of a filament.

Grid voltage.

See Electrode voltage.

Direct grid bias.

Direct grid bias is the direct component of grid voltage.

Note.—This is commonly called grid bias.

Electrode current.

Electrode current is the current passing to or from an electrode through the vacuous space.

Anode current.

See Electrode current.

Cathode current.

Cathode current is the total current passing to or from the cathode through the vacuous space.

Heater current.

Heater current is the current flowing through a heater.

Filament current.

Filament current is the current supplied to a filament to heat it.

Grid current.

See Electrode current.

Grid emission.

Grid emission is electron or ion emission from a grid.

Leakage current.

Leakage current is a conductive current which flows between two or more electrodes by any path other than across the vacuous space.

Electrode characteristic.

An electrode characteristic is a relation, usually shown by a graph, between an electrode voltage and current, other electrode voltages being maintained constant.

Transfer characteristic.

A transfer characteristic is a relation, usually shown by a graph, between the voltage of one electrode and the current to another electrode, all other voltages being maintained constant.

Emission characteristic.

An emission characteristic is a relation, usually shown by a graph, between the emission and a factor controlling the emission (as temperature, voltage or current of the filament or heater).

Electrode dissipation.

Electrode dissipation is the power dissipated in the form of heat by an electrode as a result of electron and/or ion bombardment.

Grid driving power.

Grid driving power is the average product of the instantaneous value of the grid current and the alternating component of the grid voltage over a complete cycle.

Note.—This comprises the power supplied to the biasing device and the grid dissipation.

*Electrode Impedances and Admittances**Mu factor.*

Mu factor is the ratio of the change in one electrode voltage to the change in another electrode voltage, under the conditions that a specified current remains unchanged and that all other electrode voltages are maintained constant. It is a measure of the relative effect of the voltages on two electrodes upon the current in the circuit of any specified electrode.

Note.—As most precisely used, the term refers to infinitesimal changes.

Amplification factor.

Amplification factor is the ratio of the change in plate voltage to a change in control electrode voltage, under the conditions that the plate current remains unchanged and that all other electrode voltages are maintained constant. It is a measure of the effectiveness of the control-electrode voltage relative to that of the plate voltage upon the plate current. The sense is usually taken as positive when the voltages are changed in opposite directions.

Note.—As most precisely used, the term refers to infinitesimal changes.

Amplification factor is a special case of mu factor.

Electrode admittance.

Electrode admittance is the quotient of the alternating component of the

electrode current by the alternating component of the electrode voltage, all other electrode voltages being maintained constant.

Note.—As most precisely used, the term refers to infinitesimal amplitudes.

Transadmittance.

Transadmittance from one electrode to another is the quotient of the alternating component of the current of the second electrode by the alternating component of the voltage of the first electrode, all other electrode voltages being maintained constant.

Note.—As most precisely used, the term refers to infinitesimal amplitudes.

Electrode impedance.

Electrode impedance is the reciprocal of the electrode admittance.

Electrode conductance.

Electrode conductance is the quotient of the in-phase component of the electrode alternating current by the electrode alternating voltage, all other electrode voltages being maintained constant.

Note.—This is a variational and not a total conductance. As most precisely used, the term refers to infinitesimal amplitudes.

Plate conductance.

See Electrode conductance.

Grid conductance.

See Electrode conductance.

Transconductance.

Transconductance from one electrode to another is the quotient of the in-phase component of the alternating current of the second electrode by the alternating voltage of the first electrode, all other electrode voltages being maintained constant.

Note.—As most precisely used, the term refers to infinitesimal amplitudes.

See Control grid—Plate transconductance.

Control grid—Plate transconductance. (Transconductance) (Mutual conductance)

Control grid—plate transconductance is the name for the plate current to control grid voltage transconductance.

Note.—This is ordinarily the most important transconductance and is commonly understood when the term transconductance or mutual conductance is used.

Mutual conductance.

See Control grid—Plate transconductance.

Electrode resistance.

Electrode resistance is the reciprocal of the electrode conductance.

Note.—This is the effective parallel resistance and is not the real component of the electrode impedance.

Plate resistance.

See Electrode resistance.

Interelectrode capacitance.

Interelectrode capacitance is the direct capacitance between two electrodes.

Electrode capacitance.

Electrode capacitance is the capacitance of one electrode to all other electrodes connected together.

Input capacitance.

The input capacitance of a vacuum tube is the sum of the direct capacitances between the control grid and the cathode and such other electrodes as are operated at the alternating potential of the cathode.

Note.—This is not the effective capacitance, which is a function of the impedances of the associated circuits.

Output capacitance.

The output capacitance of a vacuum tube is the sum of the direct capacitances between the output electrode (usually the plate) and the cathode and such other electrodes as are operated at the alternating potential of the cathode.

Note.—This is not the effective capacitance, which is a function of the impedances of the associated circuits.

*Amplifiers**Amplifier.*

An amplifier is a device for increasing the power associated with a phenomenon without appreciably altering its quality, through control by the amplifier input of a larger amount of power supplied by a local source to the amplifier output.

Class A amplifier.

A class A amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows at all times.

Note.—To denote that grid current does not flow during any part of the input cycle, the suffix 1 may be added to the letter or letters of the class identification. The suffix 2 may be used to denote that grid current flows during some part of the cycle.

Class AB amplifier.

A class AB amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows for appreciably more than half but less than the entire electrical cycle.

Note.—See note under Class A amplifier.

Class B amplifier.

A class B amplifier is an amplifier in which the grid bias is approximately equal to the cut-off value so that the plate current is approximately zero when no exciting grid voltage is applied, and so that plate current in a specific tube flows for approximately one-half of each cycle when an alternating grid voltage is applied.

Note.—See note under Class A amplifier.

Class C amplifier.

A class C amplifier is an amplifier in which the grid bias is appreciably greater than the cut-off value so that the plate current in each tube is zero when no alternating grid voltage is applied, and so that plate current flows in a specific tube for appreciably less than one-half of each cycle when an alternating grid voltage is applied.

Note.—See note under Class A amplifier.

*Gas Tubes**Tube voltage drop.*

Tube voltage drop in a gas tube is the anode voltage during the conducting period.

Critical grid voltage.

Critical grid voltage in a gas tube is the instantaneous value of grid voltage when the anode current starts to flow.

Critical grid current.

Critical grid current in a gas tube is the instantaneous value of grid current when the anode current starts to flow.

Control characteristic.

The control characteristic of a gas tube is a relation, usually shown by a graph, between critical grid voltage and anode voltage.

Cathode heating time.

Cathode heating time is the time required for the cathode to attain operating temperature with normal voltage applied to the heating element.

Tube heating time.

Tube heating time in a mercury-vapor tube is the time required for the coolest portion of the tube to attain operating temperature.

*Phototubes**Static sensitivity (of a phototube).*

Static sensitivity of a phototube is the quotient of the direct anode current by the incident radiant flux of constant value.

Dynamic sensitivity (of a phototube).

Dynamic sensitivity of a phototube is the quotient of the alternating component of anode current by the alternating component of incident radiant flux.

Note.—This is a variational and not a total sensitivity. As most precisely used, the term refers to infinitesimal amplitudes.

Luminous sensitivity (of a phototube).

Luminous sensitivity of a phototube is the quotient of the anode current by the incident luminous flux.

2870 Tungsten sensitivity (of a phototube).

2870 tungsten sensitivity of a phototube is the quotient of the anode current by the total incident luminous flux in lumens from a tungsten filament lamp at a color temperature of 2870 degrees Kelvin.

Gas amplification factor (of a phototube).

Gas amplification factor of a phototube is the factor of increase in the sensitivity of a gas phototube due solely to the ionization of the contained gas.

Note.—For a gas phototube having a structure such as to permit saturation to occur at a voltage less than that causing appreciable ionization, the gas amplification factor at a specified operating voltage is the ratio of the sensitivity measured at that voltage to the sensitivity measured at the saturation voltage.

Current-wavelength characteristic (of a phototube).

Current-wavelength characteristic of a phototube is a relation, usually shown by a graph, between the direct anode current per unit energy of the incident radiant flux and the wavelength of the flux.

*Cathode-Ray Oscillograph Tubes**Gas focusing.*

Gas focusing is a method of focusing an electron stream in which focus is produced through the action of ionized gas.

Electrostatic focusing.

Electrostatic focusing is a method of focusing an electron stream in which focus is produced through the action of an electric field.

Magnetic focusing.

Magnetic focusing is a method of focusing an electron stream in which focus is produced through the action of a magnetic field.

Deflection sensitivity (of a cathode-ray oscillograph tube).

The deflection sensitivity of a cathode-ray oscillograph tube is the quotient of the displacement of the electron beam at the place of impact by the change in the deflecting field.

Note.—It is usually expressed in millimeters per volt applied between the deflection electrodes, or in millimeters per gauss of the deflecting magnetic field.

Deflection factor (of a cathode-ray oscillograph tube).

The deflection factor of a cathode-ray oscillograph tube is the reciprocal of the deflection sensitivity.

*Not Otherwise Classified**Rectifier.*

A rectifier is a device which converts alternating current into unidirectional current by virtue of a characteristic permitting appreciable flow of current in only one direction.

Mercury-arc rectifier.

A mercury-arc rectifier is a rectifier which makes use of the rectifying properties of an electron-emitting cathode and non-electron-emitting anodes enclosed in a chamber containing mercury vapor.

Metal tank mercury-arc rectifier.

A metal tank mercury-arc rectifier is a mercury-arc rectifier with the anodes and mercury cathode enclosed in a metal container or chamber.

Controlled mercury-arc rectifier.

A controlled mercury-arc rectifier is a mercury-arc rectifier in which one or more electrodes are employed to control the starting of the discharge.

Discharge tube.

A discharge tube is an evacuated enclosure containing a gas at low pressure which permits the passage of electricity through the gas upon application of sufficient voltage.

Note.—The tube is usually provided with metal electrodes, but one form permits an electrodeless discharge with induced voltage.

Geissler tube.

A Geissler tube is a special form of discharge tube for showing the luminous effects of discharges through rarefied gases.

Note.—The density of gas is roughly one-thousandth of that of the atmosphere.

Cathode glow.

The cathode glow is the luminous glow which covers the surface of the cathode in a discharge tube, between the cathode and the cathode dark space.

Cathode dark space. (Crookes dark space)

The cathode dark space is the relatively non-luminous region in a discharge tube between the cathode glow and the negative glow.

Negative glow.

The negative glow is the luminous glow in a discharge tube between the cathode dark space and the Faraday dark space.

Faraday dark space.

The Faraday dark space is the relatively non-luminous region in a discharge tube between the negative glow and the positive column.

Positive column.

The positive column is the luminous glow, often striated, in a discharge tube between the Faraday dark space and the anode.

Symbols

See Plates 1-9, inclusive.

Action Recommended

Acceptance for submission to letter ballot.

COMPONENT	SYMBOLS	TYPICAL APPLICATION OF SYMBOLS
ELECTRODES A - EMITTING a - DIRECTLY-HEATED CATHODE (FILAMENT TYPE)  b - INDIRECTLY-HEATED CATHODE  c - COLD CATHODE (INCLUDING IONIC-HEATED CATHODE)  d - PHOTOELECTRIC CATHODE  e - POOL CATHODE  f - IONIC-HEATED CATHODE WITH SUPPLEMENTARY HEATER  B - CONTROLLING a - GRID (INCLUDING BEAM-CONFINING OR BEAM-FORMING ELECTRODES)  b - DEFLECTING, REFLECTING, OR REPELLING ELECTRODE (ELECTROSTATIC TYPE)  c - IGNITOR  d - EXCITOR (CONTACTOR TYPE)  C - COLLECTING a - ANODE OR PLATE (INCLUDING COLLECTOR AND FLUORESCENT TARGET)  b - TARGET OR X-RAY ANODE  c - ROTATING ANODE, X-RAY  D - COLLECTING AND EMITTING a - DYNODE  HEATER 	ENVELOPE (SHELL) A - HIGH VACUUM  B - GAS FILLED  LOCATED AS CONVENIENT  SHIELD A - WITHIN ENVELOPE  EXTERNAL CONNECTION  B - OUTSIDE ENVELOPE (X-RAY TUBE)  COUPLING A - LOOP COUPLING (ELECTROMAGNETIC TYPE)  RESONATORS (CAVITY TYPE) A - SINGLE CAVITY ENVELOPE  B - DOUBLE CAVITY ENVELOPE  C - MAGNETRON ENVELOPE (RESONANT TYPE)  D - EXTERNAL CAVITY RESONATOR 	GENERAL NOTES a - THE DIAGRAM FOR A TUBE HAVING MORE THAN ONE HEATER SHALL SHOW ONLY ONE HEATER SYMBOL (INVERTED V) UNLESS THE HEATERS HAVE ENTIRELY SEPARATE CONNECTIONS. IF A TAP IS MADE, ONE HEATER SYMBOL SHALL STILL BE SHOWN, AND THE TAP SHALL BE SHOWN AT THE VERTEX OF THE HEATER SYMBOL, REGARDLESS OF THE ACTUAL DIVISION OF VOLTAGE ACROSS THE HEATER. b - ITEM (a) SHALL APPLY ALSO TO FILAMENTS. IN CASE OF A TAP, EITHER BROUGHT OUT TO A PIN CONNECTION, OR INTERNALLY CONNECTED AS TO A SUPPRESSOR GRID, THE TAP SHALL BE SHOWN AT THE VERTEX OF THE FILAMENT SYMBOL, REGARDLESS OF THE ACTUAL DIVISION OF VOLTAGE ACROSS THE FILAMENT. c - A TYPE HAVING MORE THAN ONE CATHODE SHALL BE SHOWN AS HAVING A SINGLE CATHODE UNLESS SEPARATE CATHODE CONNECTIONS ARE MADE. d - A TYPE HAVING TWO OR MORE GRIDS TIED INTERNALLY SHALL BE SHOWN WITH SYMBOLS FOR EACH GRID, EXCEPT WHEN THE GRIDS ARE ADJACENT IN THE TUBE STRUCTURE. THUS THE DIAGRAM FOR A TWIN DIODE HAVING A COMMON SCREEN GRID CONNECTION FOR EACH SECTION AND FOR A CONVERTER TUBE HAVING THE NO. 3 AND NO. 5 GRIDS CONNECTED INTERNALLY WILL SHOW SEPARATE SYMBOLS FOR EACH GRID. HOWEVER, A TRIODE WHERE THE CONTROL GRID IS PHYSICALLY IN THE FORM OF TWO GRID WINDINGS WOULD SHOW ONLY ONE GRID. e - A TYPE HAVING A GRID ADJACENT TO A PLATE BUT INTERNALLY CONNECTED TO THE PLATE TO FORM A PORTION OF IT SHALL BE SHOWN AS HAVING A PLATE ONLY. f - ASSOCIATED PARTS OF A CIRCUIT SUCH AS FOCUSING COILS, DEFLECTING COILS, FIELD COILS, ETC. ARE NOT A PART OF THE TUBE SYMBOL BUT MAY BE ADDED TO THE CIRCUIT IN THE FORM OF STANDARD SYMBOLS AS SHOWN IN ASA Z32.3 OR ASA Z32.5. FOR EXAMPLE, RESONANT-TYPE MAGNETRON PLUS SYMBOL FOR FERRO-MAGNETIC INDUCTOR WOULD BE SHOWN.  g - CONVENTIONS MAY BE ROTATED ON THE DRAWING TO FIT THE CIRCUIT BEING PREPARED.

Plate 1.

TYPICAL APPLICATION OF SYMBOLS

TRIODE WITH FILAMENTARY CATHODE

TRIODE WITH INDIRECTLY-HEATED CATHODE AND ENVELOPE CONNECTION

TYPICAL WIRING FIGURE

THIS FIGURE ILLUSTRATES HOW TUBE SYMBOLS MAY BE PLACED IN ANY CONVENIENT POSITION IN A CIRCUIT

PENTODE (SUPPRESSOR OR BEAM-CONFINING ELECTRODES)

DIODE (COLD CATHODE AND GAS CONTENT)

PHOTOTUBES

A- VACUUM TYPE

B- MULTIPLIER TYPE

CATHODE-RAY TUBES

A- WITH ELECTROSTATIC DEFLECTION

B- FOR MAGNETIC DEFLECTION

MERCURY POOL TUBES

A- WITH IGNITOR AND CONTROL GRID

B- WITH EXCITOR, CONTROL GRID, AND HOLDING ANODE

MAGNETRON TUBES

A- RESONANT TYPE

B- TRANSIT-TIME SPLIT-PLATE TYPE WITH STABILIZING DEFLECTING ELECTRODES AND INTERNAL CIRCUIT

VELOCITY-MODULATION (VELOCITY-VARIATION) TUBES

A- SINGLE-CAVITY TYPE WITH REFLECTING ELECTRODE

B- DOUBLE-CAVITY TYPE WITH COLLECTING ELECTRODE

C- REFLEX VELOCITY MODULATION TUBE WITH EXTERNAL CAVITY RESONATOR

TUBE BASING CONVENTIONS

BASING ORIENTATION SYMBOLS

A- FOR TUBES WITH KEYED BASES

B- FOR TUBES WITH BAYONETS, BOSSES, AND OTHER REFERENCE POINTS

TUBE TERMINALS

A- BASE TERMINALS

SMALL PIN

LARGE PIN

B- ENVELOPE TERMINALS

RIGID TERMINAL

FLEXIBLE LEAD

GENERAL APPLICATION

A- TRIODE WITH INDIRECTLY-HEATED CATHODE AND ENVELOPE CONNECTED TO BASE TERMINAL

B- TRIODE-HEPTODE WITH RIGID ENVELOPE CONNECTION

C- ULTRA-HIGH-FREQUENCY TRIODE (DISC-SEAL TUBE TYPE)

D- RECTIFIER WITH HEATER TAP

NOTE:

IN LINE WITH STANDARD DRAFTING PRACTICE, STRAIGHT-LINE CROSSOVERS ARE RECOMMENDED. IF CONDITIONS DEMAND THEM, LOOP CROSSOVERS MAY BE USED.

SYMBOL COMPONENTS			
CONTACT		CORE	VARIABLE
A - ADJUSTABLE OR SLIDING CONTACT OR REGULAR CONTACT FOR RELAYS, KEYS, JACKS, ETC.		A - AIR (NO SYMBOL, INDICATE AIR CORE WHEN REQUIRED)	A - GENERAL
B - MOVING CONTACT OR ARMATURE FOR RELAYS, NON-LOCKING KEYS, JACKS, ETC.		B - MAGNETIC (GENERAL)	B - ADAPTATIONS
(CIRCLE INDICATES PIVOT POINT AND IS ALWAYS SHOWN ON MOVING CONTACTS)		C - RELAY OR MAGNET	VARIABLE OR ADJUSTABLE INDUCTOR
C - MOVING CONTACT FOR LOCKING KEYS, JACKS, ETC.		D - ADAPTATIONS	VARIABLE OR ADJUSTABLE RESISTOR
(CIRCLE INDICATES PIVOT POINT AND IS ALWAYS SHOWN ON MOVING CONTACTS)		AIR-CORE INDUCTOR	VARIABLE OR ADJUSTABLE CAPACITOR
D - VIBRATOR REED		AIR-CORE TRANSFORMER	WINDING
USE ONLY ONE DASH		MAGNETIC-CORE INDUCTOR	A - INDUCTIVE
SPLIT REED		MAGNETIC-CORE TRANSFORMER	B - NON-INDUCTIVE
E - SLEEVE		SINGLE-WINDING RELAY	C - DOT INDICATES INNER END OF WINDING
F - INSULATOR FOR MECHANICAL COUPLING BETWEEN MOVING CONTACTS ON JACKS, RELAYS, KEYS, ETC.		DOUBLE-WINDING RELAY	D - ADAPTATIONS
G - ADAPTATIONS OF CONTACTS AND MECHANICAL COUPLING		HEATER ELEMENT	RELAY WITH WINDINGS BROUGHT OUT TO INDIVIDUAL TERMINALS
MAKE		NOTE: TO BE USED WHERE HEAT-PRODUCING ELEMENTS ARE REQUIRED AS IN THERMOSTATS, CONSTANT TEMPERATURE CHAMBERS, ETC.	RELAY WITH CERTAIN WINDINGS INTERNALLY CONNECTED AND BROUGHT OUT TO A COMMON TERMINAL
BREAK		SHIELDING	RELAY WITH CERTAIN WINDINGS INTERNALLY CONNECTED AND BROUGHT OUT TO COMMON TERMINALS
TRANSFER		A - GENERAL	
RELAY COMBINATION MAKE BREAK MAKE		B - ADAPTATIONS	
RELAY COMBINATION MAKE-BREAK MAKE		SHIELDED CAPACITOR	
RELAY COMBINATION WITH MECHANICAL COUPLING		SHIELDED WIRES	
NOTE: WHERE SIMPLE CONTACTS ONLY ARE INVOLVED, THE FOLLOWING SYMBOLS ARE ACCEPTABLE:		SHIELDED WIRES WITH SHIELD GROUNDED	
NORMALLY OPEN		SHIELDED WIRES WITH SHIELD GROUNDED	
NORMALLY CLOSED			

Plate 3.

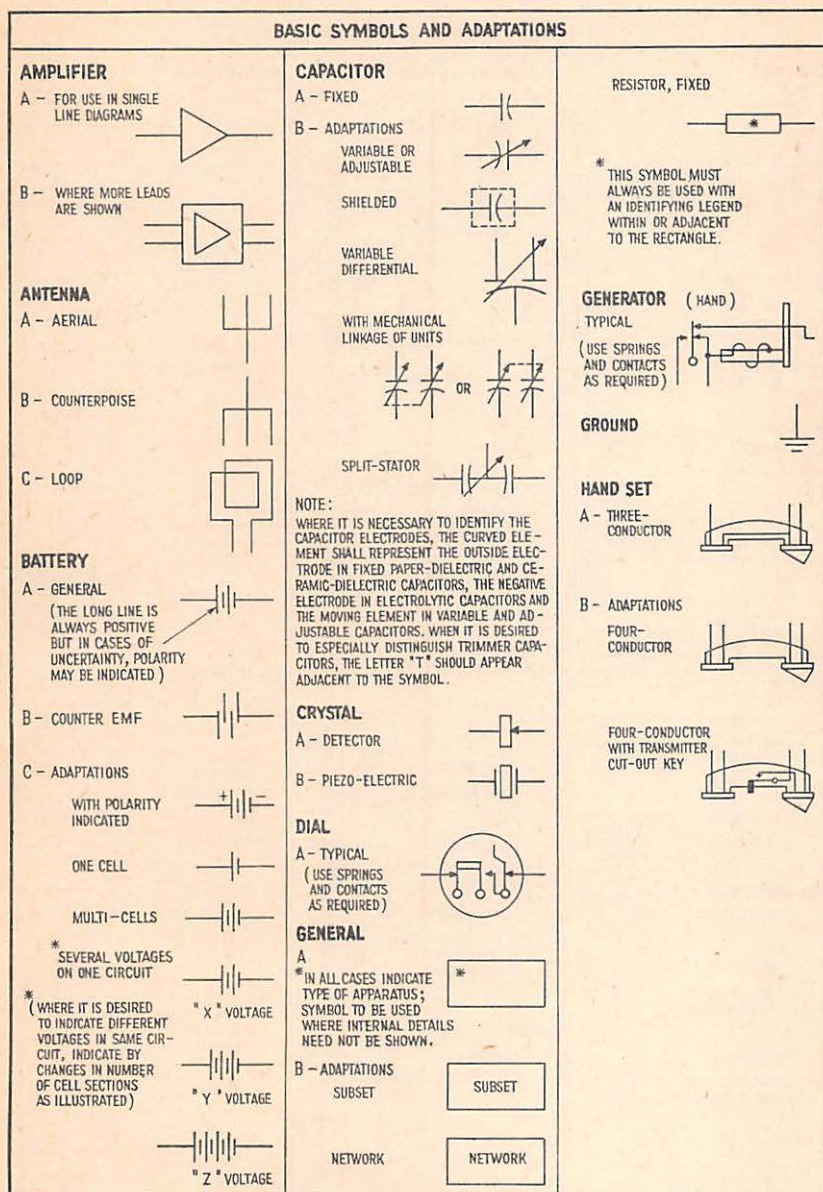


Plate 4.

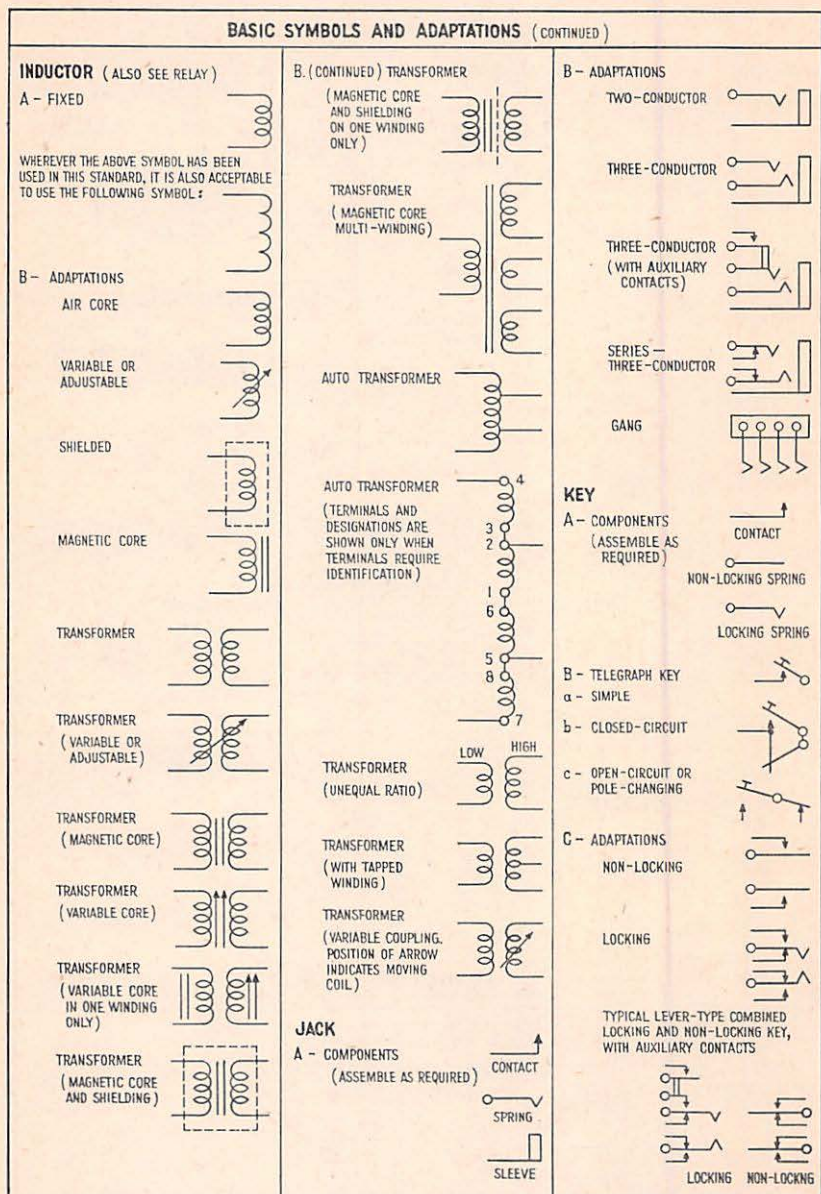


Plate 5.

BASIC SYMBOLS AND ADAPTATIONS (CONTINUED)

LAMP

A - SWITCHBOARD

B - ILLUMINATING

C - BALLAST OR RESISTANCE

LOUDSPEAKER, HORN OR HOWLER

A - GENERAL

B - ADAPTATIONS

MAGNETIC ARMATURE

PERMANENT MAGNET, WITH MOVING COIL

ELECTROMAGNETIC, WITH MOVING COIL

ELECTROMAGNETIC, WITH MOVING COIL AND HUM-NEUTRALIZING WINDING

MESSAGE REGISTER

METER

A - GENERAL SYMBOL

* ABBREVIATIONS TO IDENTIFY THE SPECIFIC TYPE OF METER. FOR EXAMPLE:

A - AMMETER
AH - AMPERE HOUR
F - FREQUENCY
G - GALVANO-METER
MA - MILLIAMMETER
PF - POWER FACTOR
TT - TOTAL TIME
V - VOLT-METER
VA - VOLT-AMMETER
W - WATT-METER
WH - WATT HOUR
μA - MICROAMMETER

MICROPHONE (ALSO SEE TRANSMITTER)

A - GENERAL

B - ADAPTATIONS

SINGLE-BUTTON

DOUBLE-BUTTON

CONDENSER

MOVING-COIL

VELOCITY

CRYSTAL

NETWORK

A - GENERAL

NETWORK

B - ADAPTATIONS

* SPECIFIC ARRANGEMENT

* APPARATUS REPRESENTED BY THE RECTANGLES WILL BE DESIGNATED INSIDE OF EACH.

SPECIFIC ARRANGEMENT

PLUG

TYPICAL SWITCHBOARD

A - PLUG-TWO-CONDUCTOR

TYPICAL SWITCHBOARD

B - PLUG-THREE-CONDUCTOR

C - GANG

D - NON-POLARIZED

(NUMBER OF TERMINALS AS REQUIRED)

E - POLARIZED

(NUMBER OF TERMINALS AS REQUIRED)

F - THREE-CONDUCTOR, POLARIZED

RADIAL PRONG INDICATES POLARIZATION

PROTECTION

A - ARRESTOR OR PROTECTOR

a - GENERAL

b - CARBON BLOCK

c - HORN GAP

B - CIRCUIT BREAKER

C - FUSE

a - GENERAL

b - FUSE MOUNTED ON BUS BAR

c - FUSE MOUNTED ON PROTECTOR MOUNTING

D - HEAT COIL

a - HEAT COIL AND MOUNTING

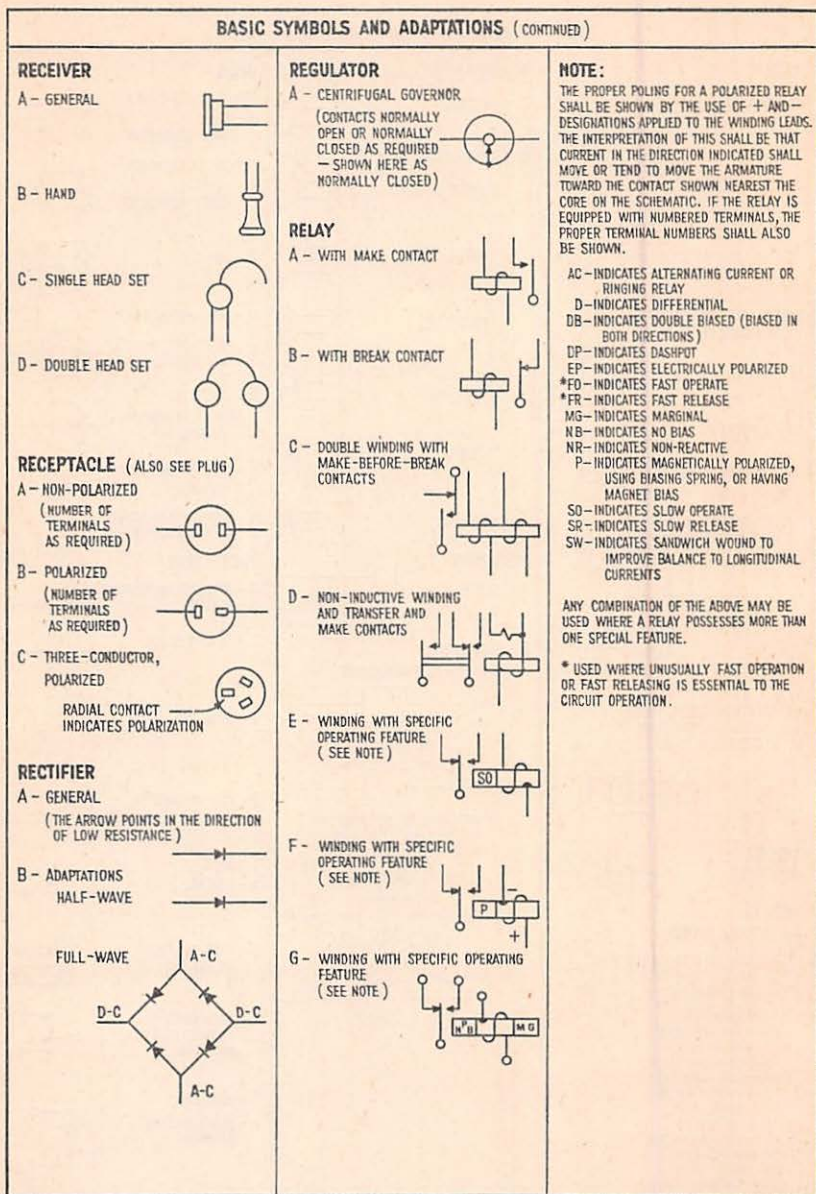
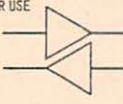
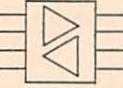
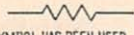
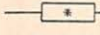
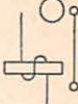
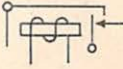
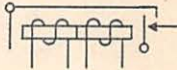
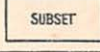


Plate 7.

BASIC SYMBOLS AND ADAPTATIONS (CONTINUED)		
REPEATER A - TWO-WIRE—FOR USE IN SINGLE LINE DIAGRAMMS  B - FOUR-WIRE—FOR USE IN SINGLE LINE DIAGRAMMS  C - ADAPTATIONS TWO-WIRE WHERE MORE LEADS ARE SHOWN  FOUR-WIRE WHERE MORE LEADS ARE SHOWN  TWO-WIRE WITH BY-PASS FOR LOW-FREQUENCY RINGER—FOR USE IN SINGLE LINE DIAGRAMMS 	RESISTOR A - FIXED  WHERE THE ABOVE SYMBOL HAS BEEN USED IN THIS STANDARD, IT IS ALSO ACCEPTABLE TO USE THE FOLLOWING SYMBOL:  * THIS SYMBOL MUST ALWAYS BE USED WITH AN IDENTIFYING LEGEND WITHIN OR ADJACENT TO THE RECTANGLE. B - ADAPTATIONS VARIABLE OR ADJUSTABLE—TWO-WIRE, OR RHEOSTAT  VARIABLE OR ADJUSTABLE—THREE-WIRE, OR VOLTAGE-DIVIDER  TAPPED  TAPPED THREE-LEAD, OR VOLTAGE-DIVIDER TYPE  WITH TERMINALS 	c - A-C BELL  C - BUZZER α - BUZZER  b - D-C BUZZER  c - A-C BUZZER  D - DROPS α - MANUALLY RESTORED  b - ELECTRICALLY RESTORED  E - RINGER  F - SOLENOID α - PLUNGER-TYPE  SOUNDER—TELEGRAPH A - GENERAL  B - ADAPTATION WITH CONTACT  SUBSET 

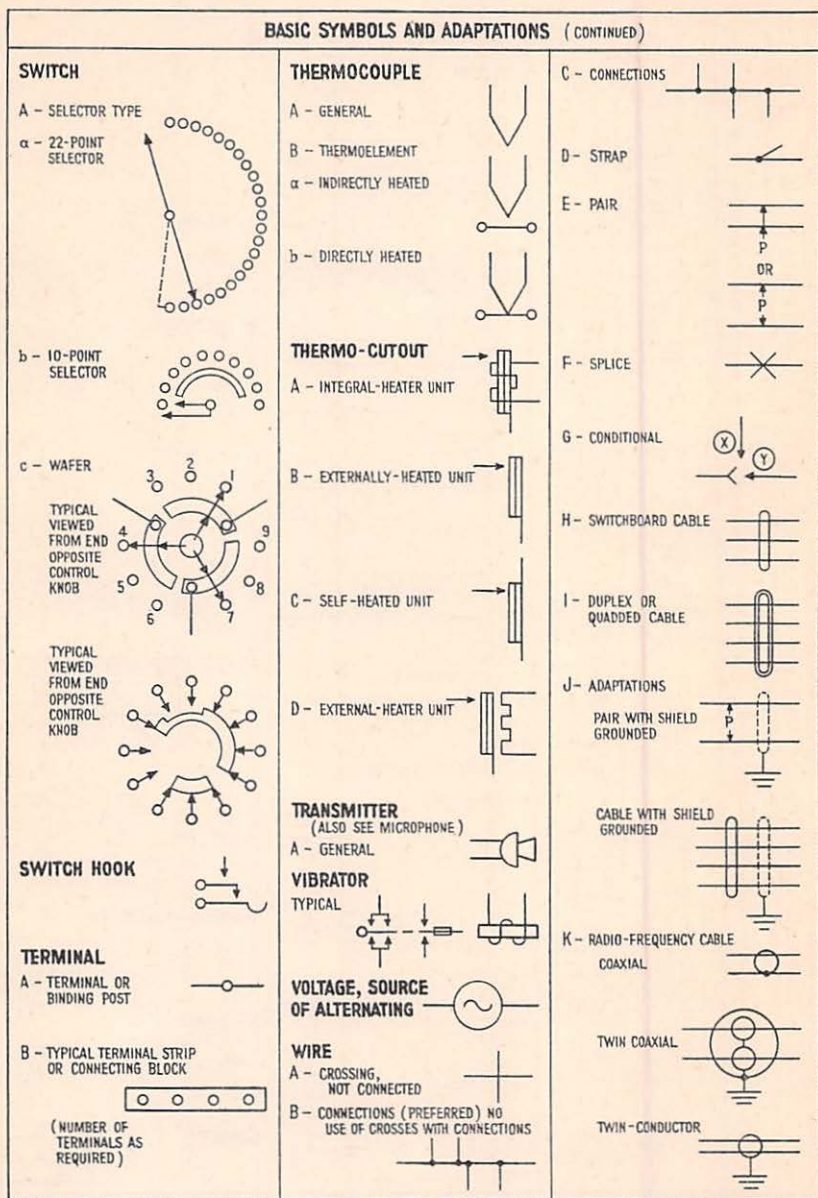


Plate 9.

COMMITTEE XII—CIRCUIT DESIGN

Personnel

W. W. Welsh, Chairman

H. A. Scott, Jr., Vice-Chairman

B. E. Brooksby	H. L. Kruke
T. L. Carlson	J. H. Molloy
W. H. Claus	E. Pitt
B. R. Dellinger	D. H. Steiner
A. L. Essman	C. L. Steinmetz
O. C. French	R. E. Testerman
A. N. Goodson	W. M. Whitehurst
H. A. Haines	F. Youngwerth
H. L. Hinton	A. Langdon*
E. W. Horning	H. A. Thompson*

Signal Section, A.A.R.:

The following outline of work has been assigned:

1. Indexing signal literature.
2. Prepare typical circuits representing current practice for railway signaling, as follows:
 - (a) Automatic block signals.
 1. For track equipped for operation in one direction only.
 - (a) Color light type signals, conventional d.c. track circuits.
 - (b) Searchlight type signals, conventional d.c. track circuits.
 - (c) Coded track circuits with and without use of line wires.
 - (d) Electric switch locking.
 - (e) Spring switch protection.
 - (f) Approach and advance lighting.
 - (g) Light out protection.
 2. For track equipped for operation in both directions.
 - (a) Color light type signals, conventional d.c. track circuits.
 - (b) Searchlight type signals, conventional d.c. track circuits.
 - (c) Coded track circuits.
 - (d) Electric switch locking.
 - (e) Spring switch protection.
 - (f) Approach and advance lighting.
 - (g) Light out protection.
 - (b) Interlocking.
 1. Relay type interlocking, unit and route types.
 - (a) Route-check network (lever-agreement relays).
 - (b) Signal control network.
 1. Color light type signals.
 2. Searchlight type signals.

* Consulting Member.

- (b) Interlocking.—Continued.
 - (c) Signal indication.
 - (d) Time locking.
 - (e) Approach locking.
 - (f) Route locking.
 - (g) Switch locking.
 - (h) Switch control.
 - (i) Switch indication.
 - (j) Power distribution.
 - (k) Model board indications.
 - (l) Remote control circuits.
 - (m) Electric locking of hand-operated switches within interlocking limits.
 - (n) Traffic locking.
 - (o) Drawbridge protection.
- (c) Highway crossing signal protection.
 - 1. Control arrangement.
 - (a) Selective speed controls.
 - (b) Interconnection with street traffic signal devices.
 - 2. Types of protection.
 - (a) Flashing lights.
 - (b) Automatic and semi-automatic gates.
- (d) Wayside typical circuits for train stop, train control, and cab signals.
 - 1. Continuous.
 - 2. Intermittent.
- (e) Miscellaneous.
 - 1. High water detectors.
 - 2. Fire and alignment detectors.
 - 3. OSing devices.
 - 4. Power and color light train order signals.
 - 5. Trap circuits.

The Committee submits for consideration, reports on the following subjects*:

- 2. A.A.R. Sig. Sec. 8027A, 8029A, and 8033A to 8042A, inclusive.

* Suggestions or criticisms should be submitted in writing to the Chairman of the Committee on or before August 15, 1949.

TYPICAL CIRCUITS REPRESENTING CURRENT PRACTICE
FOR RAILWAY SIGNALING*

The Committee presents 17 typical plans covered by its assignments for electric switch locks, automatic signals on single track (color light and searchlight), power distribution, remote control, traffic locking, drawbridge protection, continuous cab signals, fire alignment and high water detectors, OSing devices and trap circuits.

Some of these are presented for the first time. Others are alternate schemes covered by prior plans, and some are the continuation of a series of plans, part of which have already been presented.

The Committee wishes to make it clear that these plans are in no sense working drawings. They represent what is being done on some Member Roads. In applying any of the principles shown, the designer should take into account the local conditions and type of equipment to be used.

The plans presented are:

A.A.R. SIG. SEC.

- 8033A—Typical circuits for power distribution. (Assignment 2-b-1-j)
- 8034A—(Sheets 1 and 2)—Typical relay interlocking circuits for movable bridge. (Assignment 2-b-1-c)
- 8035A—Typical traffic locking circuits. (Assignment 2-b-1-n)
- 8036A—(Sheets 1, 2 and 3)—Typical remote control relay type interlocking circuits. (Assignment 2-b-1-1)
- 8037A—Typical electric switch lock circuits. (Assignment 2-a-1-d)
- 8027A—(Sheet 2)—Typical three-aspect color light automatic signal circuits at ends of siding. (Assignment 2-a-2-a)
- 8027A—(Sheet 3)—Typical three-aspect searchlight automatic signal circuits at ends of siding. (Assignment 2-a-2-b)
- 8027A—(Sheet 4)—Typical three-aspect searchlight automatic signal circuits. (Assignment 2-a-2-b)
- 8029A—(Sheet 2)—Typical three-aspect searchlight automatic signal circuits at ends of siding. (Assignment 2-a-2-b)
- 8038A—Typical circuits to superimpose coded cab signal controls on D.C. track circuits, track signaled in one direction. (Assignment 2-d-1)
- 8039A—Typical circuits to superimpose coded cab signal controls on D.C. track circuits, track signaled in both directions. (Assignment 2-d-1)
- 8040A—Typical circuits for bridge alignment, high water and fire detectors. (Assignments 2-e-1 and 2)
- 8041A—Typical circuits for OSing devices. (Assignment 2-e-3)
- 8042A—Typical trap circuits. (Assignment 2-e-5)

Action Recommended

Acceptance as information.

* Previous report on this subject appears in A.A.R. Signal Section 1947 Proceedings, Vol. XLV, pp. 365 and 387.

RULES OF ORDER

Effective April 6, 1938

Revised: December 6, 1938; May 22, 1940; March 12, 1941;

May 17, 1944; December 11, 1946.

1. **REPRESENTATIVES:** The representatives of Member Roads in the Signal Section shall be employees engaged in an official or supervisory capacity in the design, construction or maintenance of railroad signaling devices. Included within this category shall be Signal Superintendents, Signal Engineers and their Assistants, Signal Inspectors, Chief Draftsmen, Signal Supervisors and Assistant Signal Supervisors, or others with corresponding duties.
2. **AFFILIATED MEMBERS:**
 - (a) **RAILROAD AFFILIATED MEMBERS:** A member of a State or Federal regulatory body, or a railroad employee not embraced within the provisions of paragraph 1 (including those temporarily relieved from service or furloughed) may become a **RAILROAD AFFILIATED MEMBER** upon approval of his application by the Committee of Direction. Such a member will pay an annual fee of \$3.00 (which may be changed from year to year at the discretion of the Committee of Direction), on January 1st of each year, for which he will receive currently the Advance Notices and Minutes of the Section.
 - (b) **AFFILIATED MEMBERS:** A representative of an organization or an individual engaged in the design, manufacture, sale or construction of signal devices or materials applicable thereto, or one who is qualified by his business relations and practical experience to cooperate with the Section, may become an **AFFILIATED MEMBER** thereof upon approval of his application by the Committee of Direction. An Affiliated Member will pay an annual fee of \$6.00 (which may be changed from year to year at the discretion of the Committee of Direction), on January 1st of each year, for which he will receive currently the Advance Notices and Minutes of the Section.
 - (c) A Railroad Affiliated or an Affiliated Member shall have the rights and privileges accorded a Member Road representative except voting or the holding of office.
 - (d) A Railroad Affiliated or an Affiliated Member may be appointed as a Consulting Member of any Standing Committee upon the approval of the Committee of Direction.
3. **LIFE MEMBERS:** Life membership may be conferred upon members who retire from active work. They shall have been active in the affairs of the Signal Section and its predecessors and their total term of membership shall have been not less than twenty-five years. Their rights and privileges shall be continued without change. A proposal to confer Life Membership must be signed by five voting representatives of Member

Roads and five representatives of Member Roads, stating their reason for making such proposal. Proposal shall be duly considered at a meeting of the Committee of Direction and then submitted to a vote by letter to the Committee of Direction membership for approval.

Officers and Committees

4. The Officers of the Section shall consist of a Chairman, First Vice-Chairman, Second Vice-Chairman, and Secretary.

(a) The Chairman and Vice-Chairmen shall be selected by the Committee of Direction on or before November 1st. Their terms of office shall be one year from January 1st or until their successors are selected and qualified. A Chairman or Vice-Chairman having served a full term shall not succeed himself.

(b) The Secretary will be appointed by the Committee of Direction. His salary shall be named by that Committee subject to the approval of the Vice-President, Operations and Maintenance Department of the Association.

(c) The COMMITTEE OF DIRECTION will consist of twelve members, as follows: The Chairman, the First Vice-Chairman, the Second Vice-Chairman, the latest Past Chairman, one member from New England or Canada, three members from the East, one member from the South and three members from the West.

The territorial representatives, except when filling vacancies, shall serve four years and their term of office will expire on December 31st of the fourth year.

Vacancies in official positions or of territorial representatives shall be filled until the next election, by the Committee of Direction.

One Vice-Chairman shall be selected from Eastern Territory and one from Western Territory. For this purpose the Eastern Territory will consist of all territory operating under Eastern and Atlantic Standard Time. All other territory will be known as Western Territory. The location of the official's headquarters will determine whether he is in the Eastern or Western territory.

- (d) The Standing Committees of the Section will be as follows:

- I—Economics of Railway Signaling
- II—Interlocking
- III—Automatic Train Control and Signals
- IV—Automatic Block Signaling
- V—Contracts and Instructions
- VI—Designs
- VII—Materials Research
- VIII—Highway Grade Crossing Protection
- IX—Overhead and Underground Lines
- X—Signaling Practice
- XI—Electronics
- XII—Circuit Design

The representation of Member Roads on these committees will be, when practicable, territorially selected, in approximately the same proportion as that of the Committee of Direction, the personnel to be named each year by the Committee of Direction immediately following the adjournment of the Annual meeting.

Duties of Officers

5. The CHAIRMAN shall have general supervision over the affairs of the Section and shall preside at meetings of the Section and at meetings of the Committee of Direction.
6. The FIRST VICE-CHAIRMAN, in the absence of the Chairman, shall perform the duties of the Chairman. He shall perform such other duties as may be assigned to him by the Chairman.
7. The SECOND VICE-CHAIRMAN, in the absence of both the Chairman and First Vice-Chairman, shall perform the duties of the Chairman. He shall perform such other duties as may be assigned to him by the Chairman.
8. (a) The SECRETARY shall devote his entire time to the work of the Section and will perform the usual duties of that office and such other duties as may be assigned to him by the Chairman.
(b) He shall receive on or before November 20th of each year the report of the Committee on Nominations, as elsewhere provided for, and will submit to the voting representatives of Member Roads, not later than November 29th, for letter ballot vote, the nominations contained in that report, to fill the vacancies in the membership of the Committee of Direction. He shall appoint three Tellers from representatives of Member Roads to assist him in counting the ballots, who shall certify the count thereof, with him, to the Committee of Direction. He shall announce the result of the ballot to the Members promptly.
(c) He shall furnish, free of charge, to each representative of a Member Road, designated by such road, one copy of all circulars, Advance Notices and Minutes.
(d) He shall furnish to each Railroad Affiliated, Affiliated and Life Member one copy of all circulars, Advance Notices and Minutes.

Duties of Committees

9. The COMMITTEE OF DIRECTION shall:
 - (a) Exercise general supervision over the interests and affairs of the Section.
 - (b) Be empowered to act on behalf of the Section in the interim between meetings and submit at each meeting a report covering its actions.
 - (c) Examine and decide what portion of communications, papers and reports shall be submitted to the meetings. It shall determine which, if any, of the subjects presented by the various committees shall be referred to the General Committee of the Engineering Division.

- (d) Appoint on or before October 1st of each year a Committee on Nominations consisting of representatives of five Member Roads, who shall not be members of the Committee of Direction.
 - (e) Appoint additional committees as required.
 - (f) Submit to the Vice-President, Operations and Maintenance Department, detail of contemplated financial requirements for conducting the work of the Section as required or as called for by that official.
 - (g) Call Annual meetings of the Section if in its judgment conditions warrant.
 - (h) Call meetings of the Section upon not less than thirty days' notice to each member. It MUST call a special meeting of the Section upon the request in writing of a majority of the voting members of Member Roads.
 - (i) Publish Manual of Recommended Practice, in which shall be included such approved Specifications, Drawings, Findings and Conclusions of the Section as the Committee of Direction may find advisable.
10. The COMMITTEE ON NOMINATIONS, appointed as prescribed above, shall report to the Secretary on or before November 20th each year at least two nominations for each impending vacancy to replace the territorial representatives on the Committee of Direction.

The duties of the Standing Committees shall be as follows:

- 11. COMMITTEE I—ECONOMICS OF RAILWAY SIGNALING. Study and report on the economy, if any, of the various signal systems, interlocking, train control, cab signals and other signaling projects.
- 12. COMMITTEE II—INTERLOCKING. Prepare specifications for the various types of interlockings and submit reports on subject-matters relating thereto.
- 13. COMMITTEE III—AUTOMATIC TRAIN CONTROL AND SIGNALS. Report on Federal, State and Dominion activities on automatic train stop, automatic train control, automatic cab signaling, signals, interlocking, highway grade crossing protection, and related safety devices.
- 14. COMMITTEE IV—AUTOMATIC BLOCK SIGNALING. Prepare specifications for the various types of automatic block systems and submit reports on subject-matters relating thereto.
- 15. COMMITTEE V—CONTRACTS AND INSTRUCTIONS. Prepare recommended forms for use in connection with signaling contracts and prepare instructions relating to signal maintenance.
- 16. COMMITTEE VI—DESIGNS. Prepare detailed drawings for standardization purposes and make any special study or investigation assigned to it by the Committee of Direction.

17. COMMITTEE VII—MATERIALS RESEARCH. Make such investigation of materials used in connection with signaling as directed by the Committee of Direction and submit reports on its conclusions.
18. COMMITTEE VIII—HIGHWAY GRADE CROSSING PROTECTION. Prepare requisites for highway grade crossing protection and submit matters of interest relating thereto.
19. COMMITTEE IX—OVERHEAD AND UNDERGROUND LINES. Prepare specifications for overhead and underground lines and any recommendations relating to such lines which will be of interest to the Section.
20. COMMITTEE X—SIGNALING PRACTICE. Prepare requisites for the various types of interlocking and block signaling systems, make recommendations having reference to the signal indications which should be given as the varied conditions on railroads require, also submit reports on such other matters as may be assigned by the Committee of Direction.
21. COMMITTEE XI—ELECTRONICS. Investigate and report on the use of electronics in connection with railway signal systems, interlocking, centralized traffic control, and highway grade crossing protection.
22. COMMITTEE XII—CIRCUIT DESIGN. Prepare typical circuits representative of approved practices and requisites for railroad signaling.
23. REPRESENTATION OF THE SECTION UPON GENERAL COMMITTEE OF THE ENGINEERING DIVISION: The five representatives of the Signal Section upon the General Committee of the Engineering Division shall be the Chairman, First Vice-Chairman, Second Vice-Chairman, and two members of the Committee of Direction to be selected by it.
24. RECOMMENDED PRACTICES:

Any definition, nomenclature, specification, recommended construction or recommended practice or any proposition having for its objective the formal declaration of the Section upon any matter of importance shall be presented in writing (accompanied by drawings if the latter are necessary for a clear understanding of the subject).

Such submissions will be presented to the Section at its Annual meeting for discussion, and following vote to decide whether or not the proposition shall be submitted to the voting members of Member Roads for adoption or rejection by letter ballot. If the vote to submit is affirmative, the Secretary within three months from the date of the meeting will distribute the ballots with a copy of the Minutes of the meeting, requesting their return within thirty days, naming the date. Ballots mailed after that date, as shown by the postmark, will not be counted. The Secretary shall announce the result of the ballot promptly to the Members. Ballots

and envelopes shall be preserved for at least two years from date of announcement. The voting power of the Member Roads shall be as named in paragraph 26.

25. **VOTING AT MEETINGS OF SECTION:** Vote may be taken viva voce, by rising, by roll call or by ballot. Each Member Road shall be entitled to one vote, the ranking officer of a road present at any meeting being recognized as the voting representative of that road, unless otherwise designated by it. The vote of a majority of the Member Roads represented shall be required to decide any question, motion or resolution unless otherwise ordered, except that in the consideration of submitting a question to the letter ballot vote of the Member Roads, all representatives of Member Roads present at any meeting may vote. Thirty representatives of Member Roads shall constitute a quorum.

26. **LETTER BALLOTS:**

Letter ballots may be taken upon any subject by order of the Committee of Direction and *must* be taken on all questions affecting physical property. The voting power of the Member Roads shall be proportionate to ownership of signal equipment, one vote being counted for each

- 400 signals operating in two positions;
- 250 signals operating in three or four positions;
- 200 interlocked switches, power operated;
- 400 interlocked switches, manually operated;
- 250 highway crossings, automatically protected;
- 1600 train control inductors or loop circuits;
- 800 train control ramp (energized) magnet or coded circuits.

A fraction of a vote in the total of all items, if greater than one-half, shall be counted as one. Each Member Road shall have at least one vote.

Any proposition for which a majority of the votes are affirmative, shall be considered adopted.

27. **ORDER OF BUSINESS:** The order of business at meetings of the Section shall, unless otherwise directed by a majority of the members present, be as follows:

- Approval of Minutes of Last Meeting;
- Reports of Standing Committees;
- Reports of Special Committees;
- Unfinished Business;
- New Business.

28. Roberts' Rules of Order shall govern the proceedings of the Section, including amendment of these Rules of Order.

RESULT OF LETTER BALLOT ON SUBJECTS APPROVED
AT THE ANNUAL MEETING,
SEPTEMBER 14, 15 AND 16, 1948

All subjects have received the required affirmative letter ballot vote, as follows:

For Against

Committee II—Interlocking

Requisites for Yard Track Indicators for Indicating to a Train the Track to be Entered. (New.)	937	0
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Committee IV—Automatic Block Signaling

Specification 178-48—Welded Type Rail Head Bonds and Track Circuit Connectors. (Superseding section 1 of Specification 178-42, Manual Part 141.)	937	0
Specification 179-48—Mechanically Applied Rail Head Type Bonds and Track Circuit Connectors. (Superseding section 1 of Specification 179-45, Manual Part 142.)	937	0
Requisites for Automatic Block Signaling Circuits. (Superseding Requisites for Automatic Block Signaling Circuits, Manual Part 34 and Requisites for A.C. and D.C. Coded Signal Systems, Manual Part 46.)	937	0
Specification 233-48—Voice Pass Filter for Coded System Control. (New.)	937	0
Specification 234-48—Voice and Type H Pass Filter for Coded System Control. (New.)	937	0
Specification 235-48—Voice and Carrier Pass Filter for Coded System Control. (New.)	937	0
Specification 229-48—Selenium Rectifiers. (New.)	937	0

Committee V—Contracts and Instructions

Definitions for Technical Terms Used in Signaling. (To be included in Manual Part 55.)	937	0
Instructions for Non-Coded Alternating Current Track Circuits. (Superseding Instructions for Alternating Current Track Circuits, Manual Part 162.)	937	0
Instructions for Electronic Tubes. (New.)	937	0
Instructions for Storage Batteries. (Superseding Instructions 31 and 33 of Instructions for Storage Batteries, Manual Part 14.)	937	0
Instructions for Electric Locks for Interlocking Machines. (Superseding Instructions for Electric Locks for Interlocking Machines, Manual Part 23.)	937	0
Instructions for Automatic Block Signal Systems. (Superseding Instructions for Automatic Block Signaling Systems, Manual Part 102.)	937	0

For Against

Committee V—Contracts and Instructions—Continued

Instructions for Switch Circuit Controllers. (Superseding Instructions for Switch Circuit Controllers, Manual Part 134.)	937	0
Instructions for Automatic Highway Grade Crossing Protective Systems. (Superseding Instructions for Automatic Highway Grade Crossing Protective Systems, Manual Part 150.)	937	0
Instructions for Facing Point Locks Applied to Spring Switches. (Superseding Instructions for Facing Point Locks Applied to Spring Switches, Manual Part 159.)	937	0
A.A.R. Sig. Sec. 1673C (Three Sheets)—Graphical Symbols—Relays. (Superseding A.A.R. Sig. Sec. 1673B (Two Sheets) in the Manual.)	937	0
A.A.R. Sig. Sec. 1674D (Three Sheets)—Graphical Symbols—Relay Contacts. (Superseding A.A.R. Sig. Sec. 1674C (Two Sheets) in the Manual.)	937	0

Committee VI—Designs

A.A.R. Sig. Sec. 1015C—One Inch Signal Pipe and Coupling. (Superseding A.A.R. Sig. Sec. 1015B in the Manual.)	937	0
A.A.R. Sig. Sec. 1023D—Guides for Vertical Mechanical Connections for 5 and 6-Inch Masts—Assemblies. (Superseding A.A.R. Sig. Sec. 1023C in the Manual.)	937	0
A.A.R. Sig. Sec. 1059C—Clamp for Base of 6 Inch Ground Masts—Details and Assembly. (Superseding A.A.R. Sig. Sec. 1059B in the Manual.)	937	0
A.A.R. Sig. Sec. 1083D—Bolt and Clamp for 5 Inch Masts. (Superseding A.A.R. Sig. Sec. 1083C in the Manual.)	937	0
A.A.R. Sig. Sec. 1178D—Clamps for Base of 5 Inch Bridge Masts—Details and Assemblies. (Superseding A.A.R. Sig. Sec. 1178C in the Manual.)	937	0
A.A.R. Sig. Sec. 1346C—Electric Hand Lantern. (Superseding A.A.R. Sig. Sec. 1346B in the Manual.)	937	0
A.A.R. Sig. Sec. 1355C—Crank Bearings and Clamps for Base of 6 Inch Masts—Details and Assemblies. (Superseding A.A.R. Sig. Sec. 1355B in the Manual.)	937	0
A.A.R. Sig. Sec. 1357D—Ladders for Ground Masts for Two-Way Signals—Details and Assemblies. (Superseding A.A.R. Sig. Sec. 1357C in the Manual.)	937	0
A.A.R. Sig. Sec. 1362D—Ladder Parts—Details. (Superseding A.A.R. Sig. Sec. 1362C in the Manual.)	937	0
A.A.R. Sig. Sec. 1363C—Ladder Handrails—Details and Assemblies. (Superseding A.A.R. Sig. Sec. 1363B in the Manual.)	937	0
A.A.R. Sig. Sec. 1364D—Ladder Platforms—Details and Assemblies. (Superseding A.A.R. Sig. Sec. 1364C in the Manual.)	937	0

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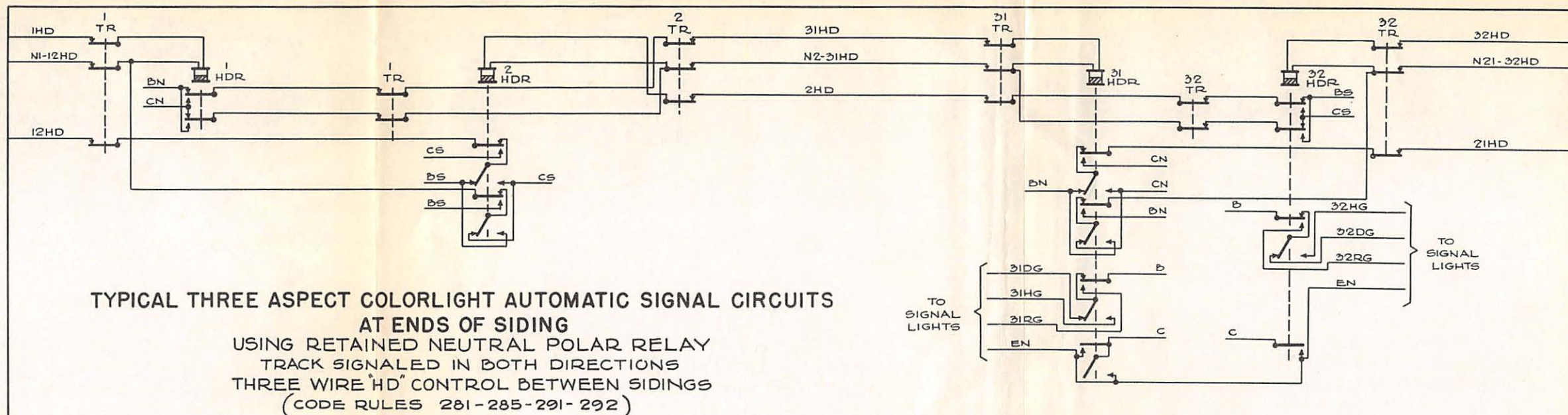
For Against

Committee IX—Overhead and Underground Lines—Continued

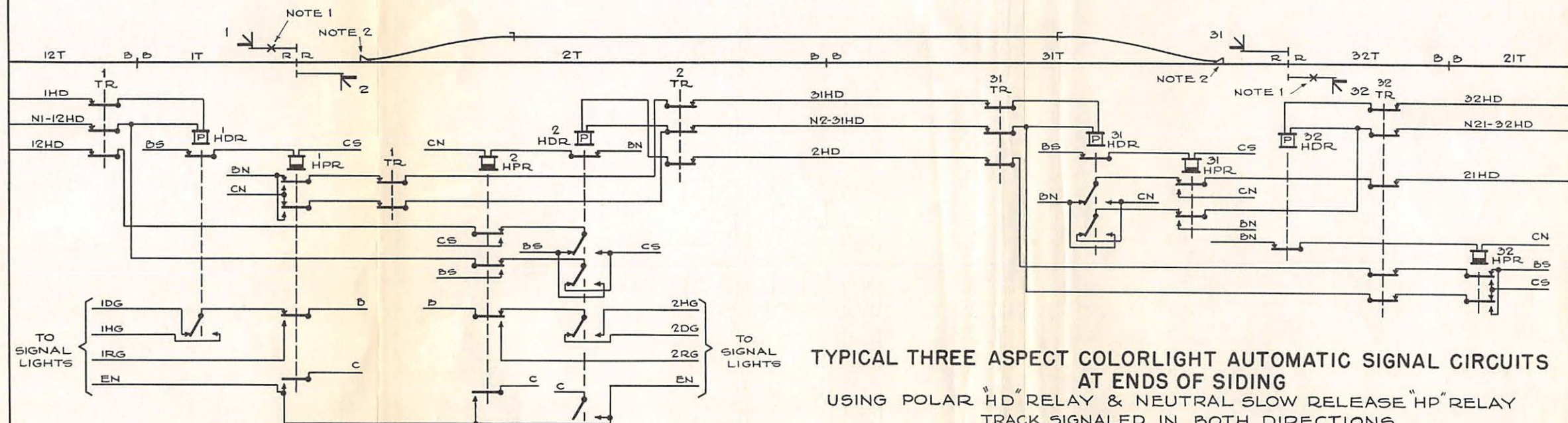
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Requisites for Interlocking. (Superseding Requisite 9 of Requisites for Interlocking, Manual Part 94.)	937	0

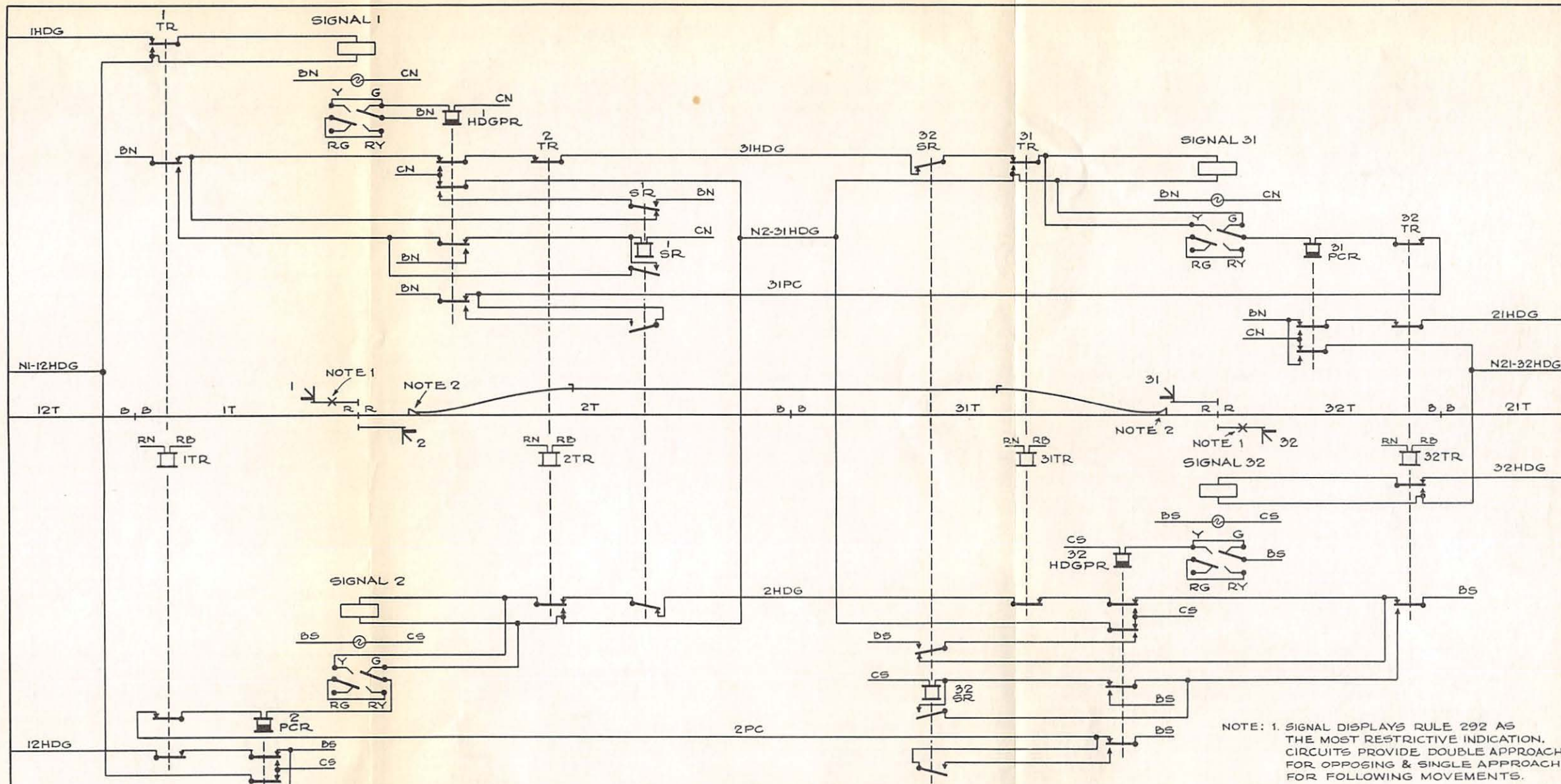


**TYPICAL THREE ASPECT COLORLIGHT AUTOMATIC SIGNAL CIRCUITS
AT ENDS OF SIDING**
USING RETAINED NEUTRAL POLAR RELAY
TRACK SIGNALLED IN BOTH DIRECTIONS
THREE WIRE 'HD' CONTROL BETWEEN SIDINGS
(CODE RULES 281-285-291-292)



**TYPICAL THREE ASPECT COLORLIGHT AUTOMATIC SIGNAL CIRCUITS
AT ENDS OF SIDING**
USING POLAR 'HD' RELAY & NEUTRAL SLOW RELEASE 'HP' RELAY
TRACK SIGNALLED IN BOTH DIRECTIONS
THREE WIRE 'HD' CONTROL BETWEEN SIDINGS
(CODE RULES 281-285-291-292)

NOTE 1. SIGNAL DISPLAYS RULE 292 AS THE MOST RESTRICTIVE INDICATION. CIRCUITS PROVIDE DOUBLE APPROACH FOR OPPOSING AND FOLLOWING MOVEMENTS.
2. DETAILS OF SWITCH PROTECTION NOT SHOWN.



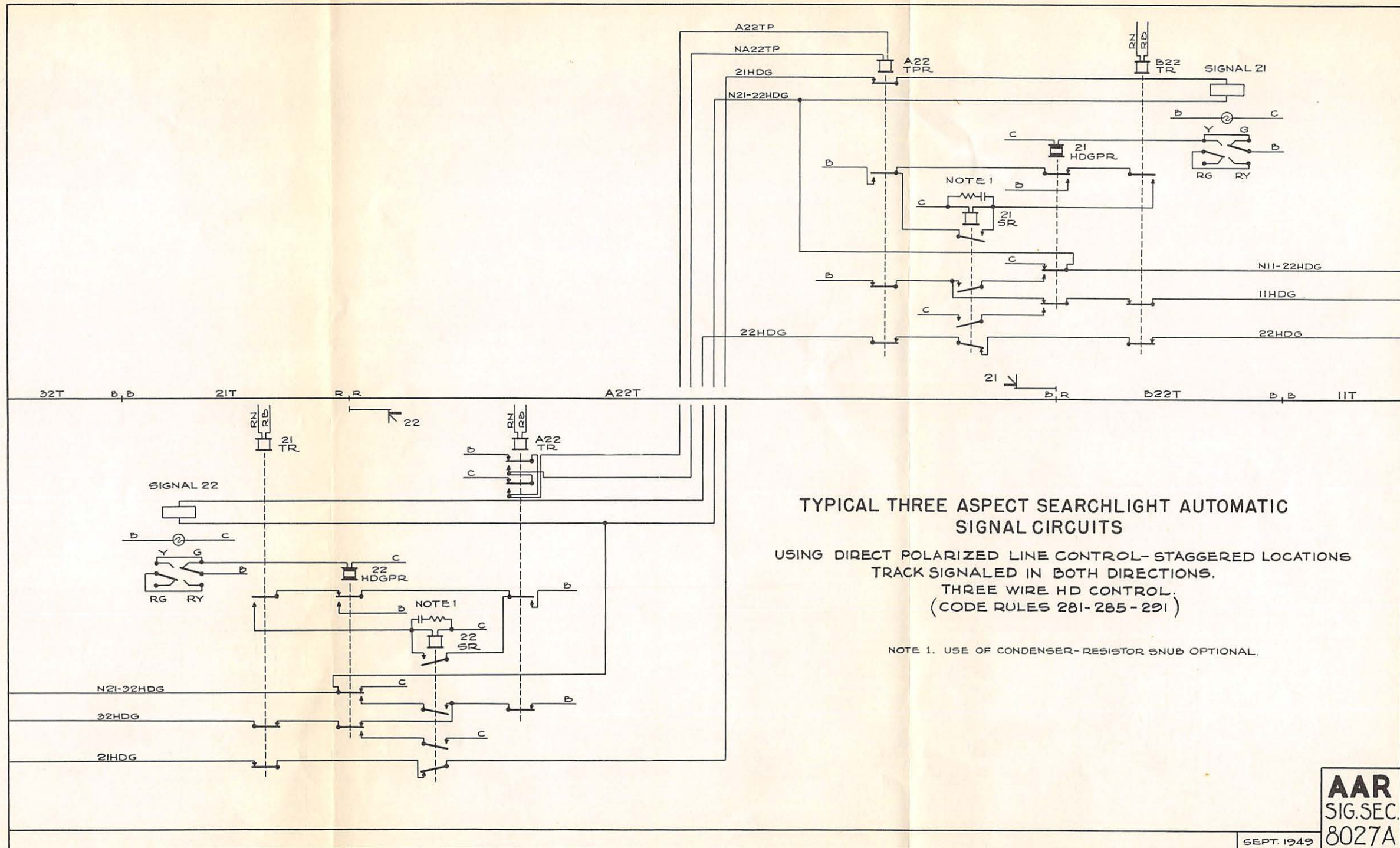
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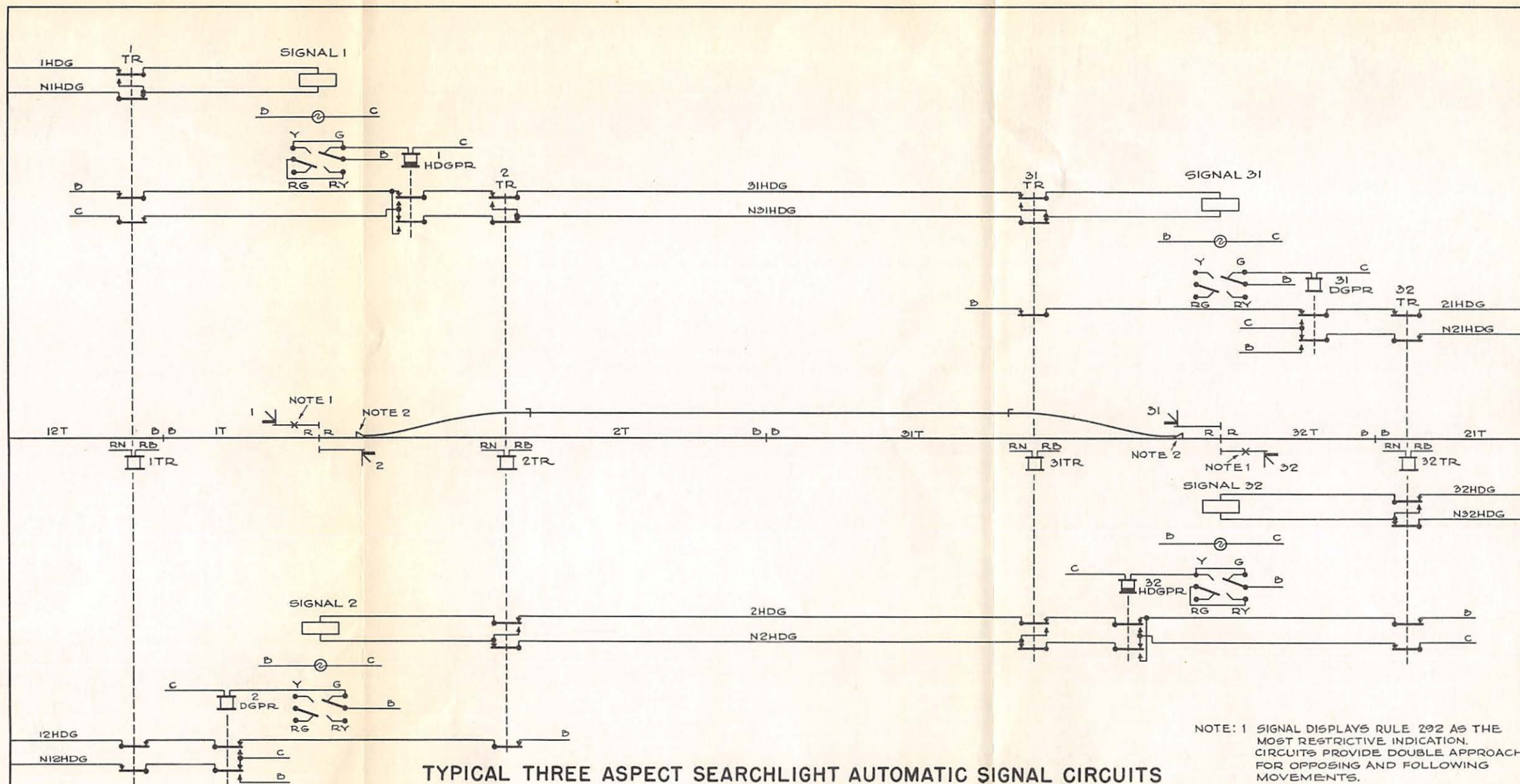
USING DIRECT POLARIZED LINE CONTROL
TRACK SIGNALLED IN BOTH DIRECTIONS
THREE WIRE "HD" CONTROL BETWEEN SIDINGS
(CODE RULES 281-285-291-292)

NOTE: 1. SIGNAL DISPLAYS RULE 292 AS
THE MOST RESTRICTIVE INDICATION.
CIRCUITS PROVIDE DOUBLE APPROACH
FOR OPPOSING & SINGLE APPROACH
FOR FOLLOWING MOVEMENTS.
2. DETAILS OF SWITCH PROTECTION
NOT SHOWN.

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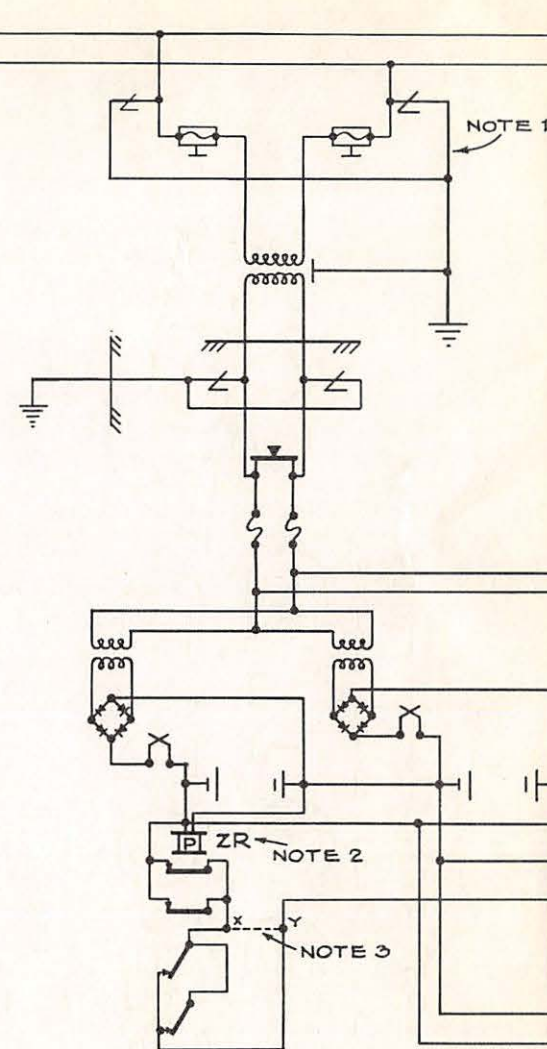
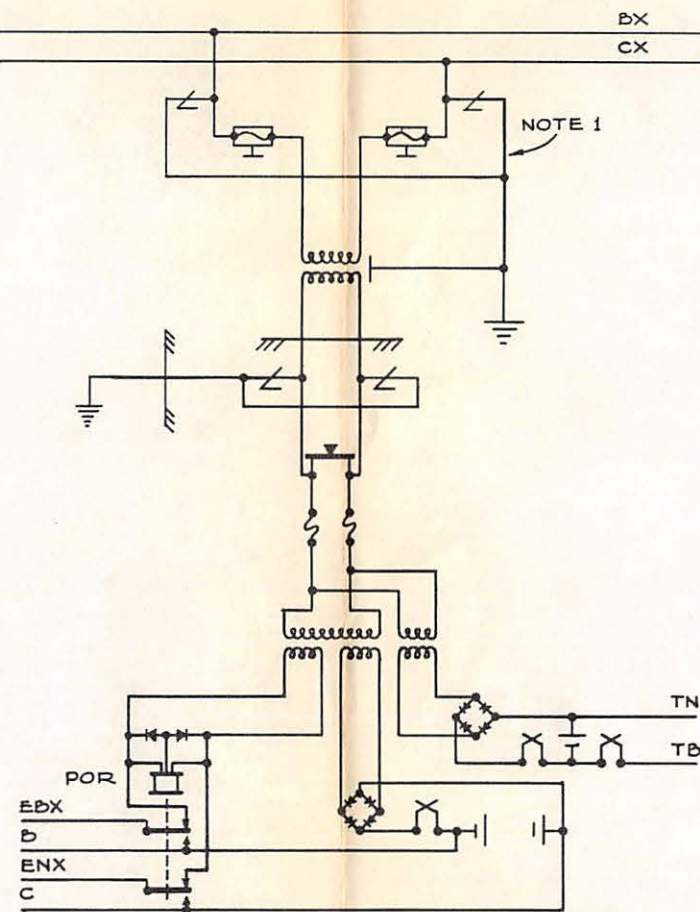




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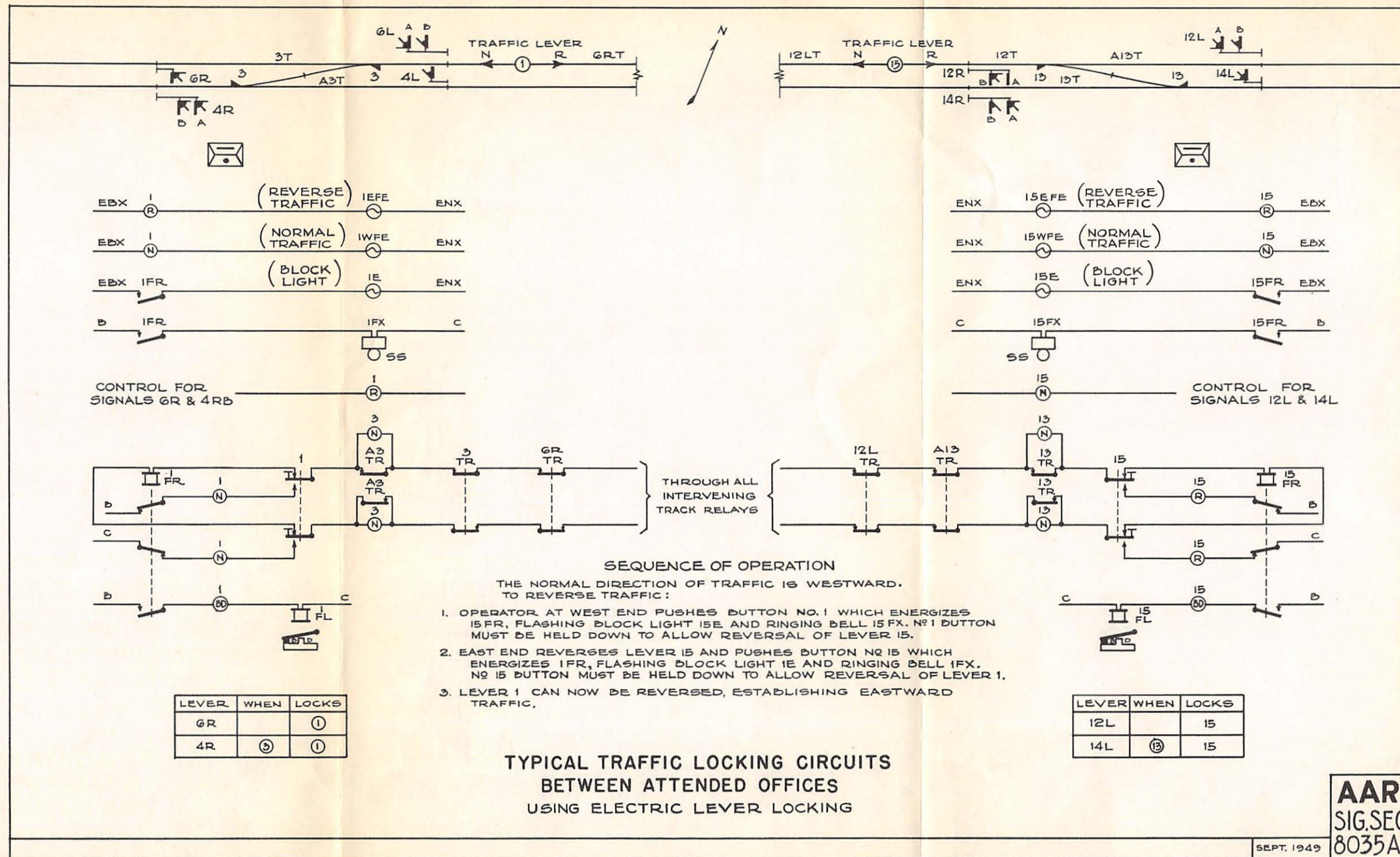
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TRACK SIGNALLED IN BOTH DIRECTIONS.
FOUR WIRE 'HD' CONTROL BETWEEN SIDINGS
(CODE RULES 281-285-291-292)

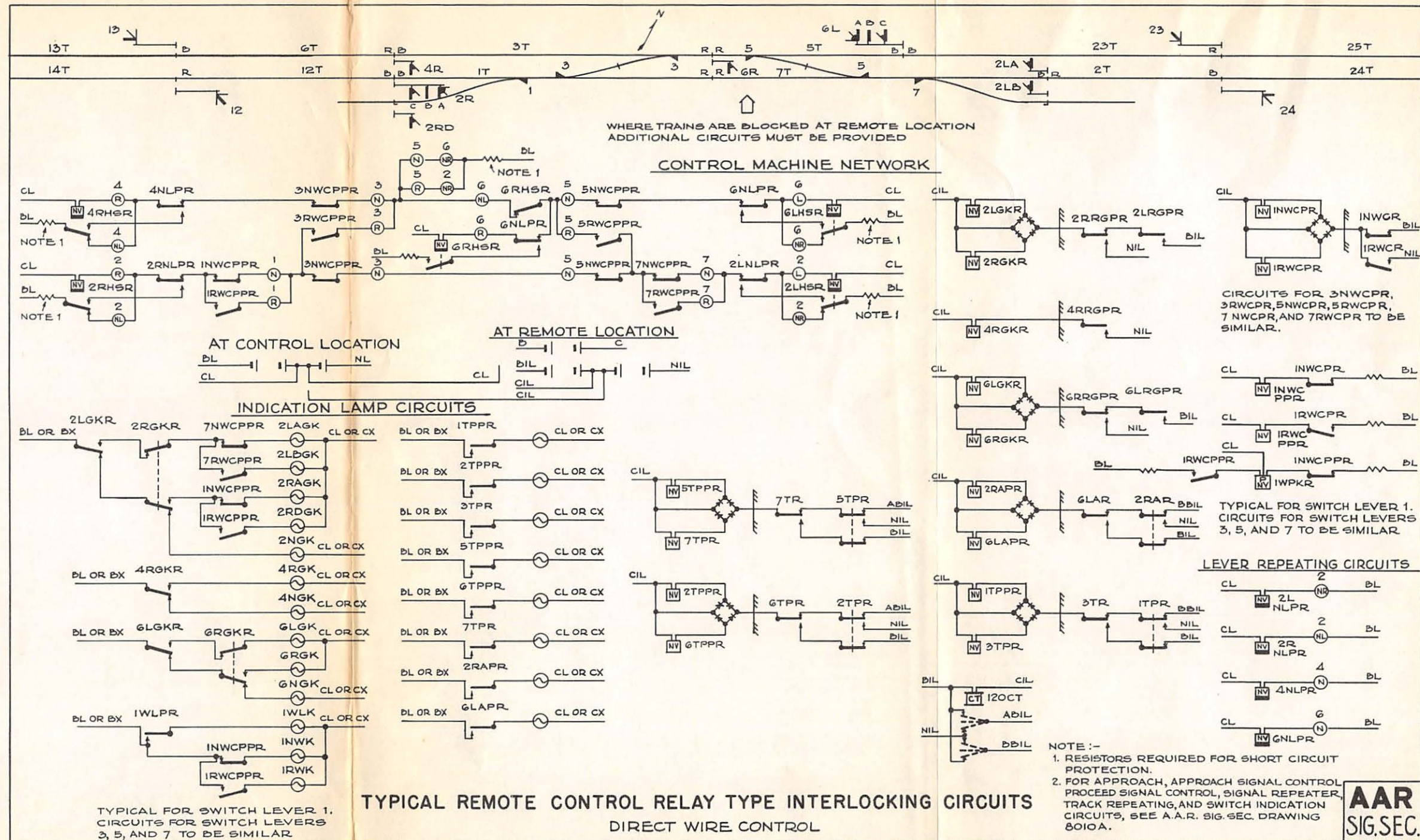
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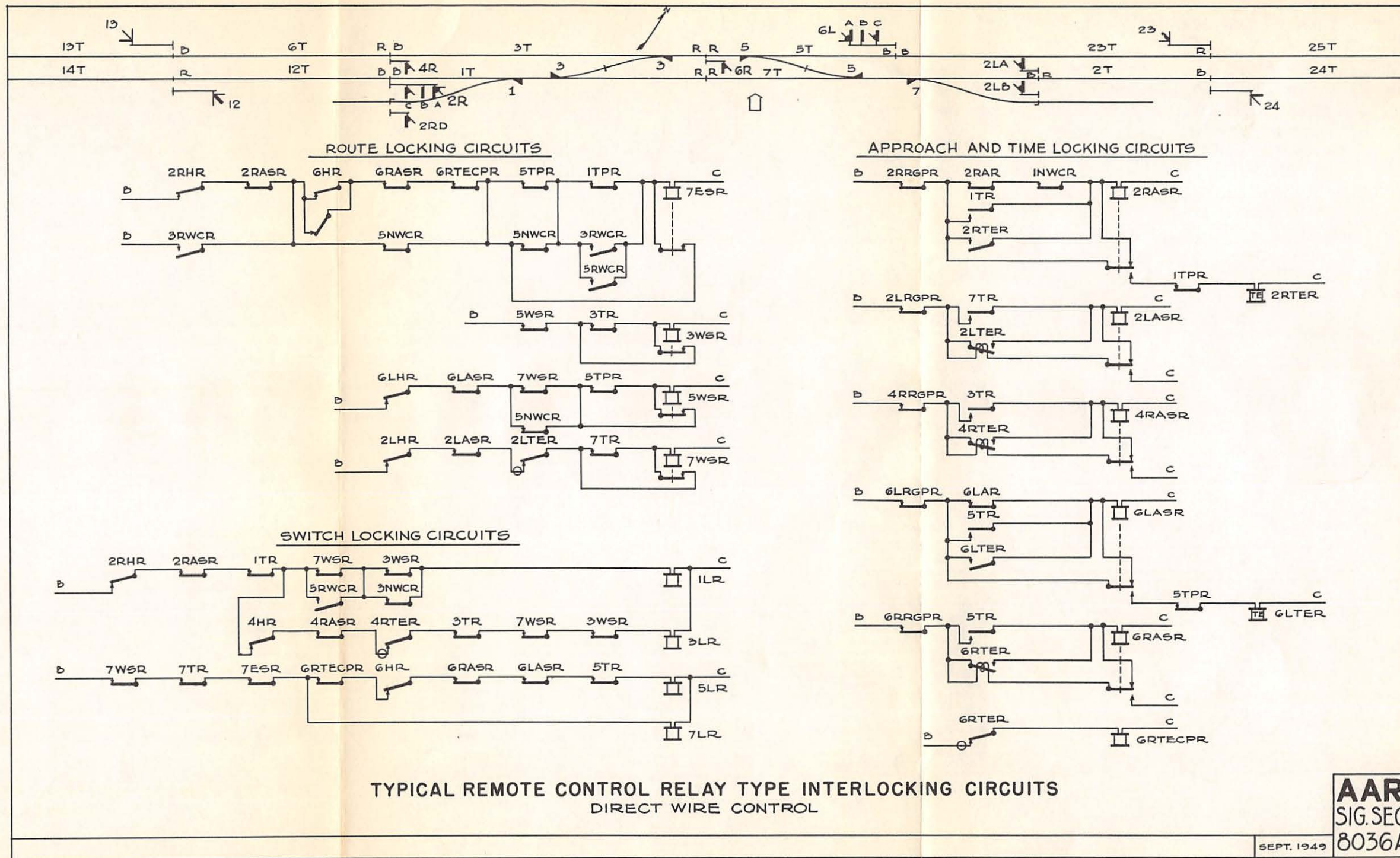


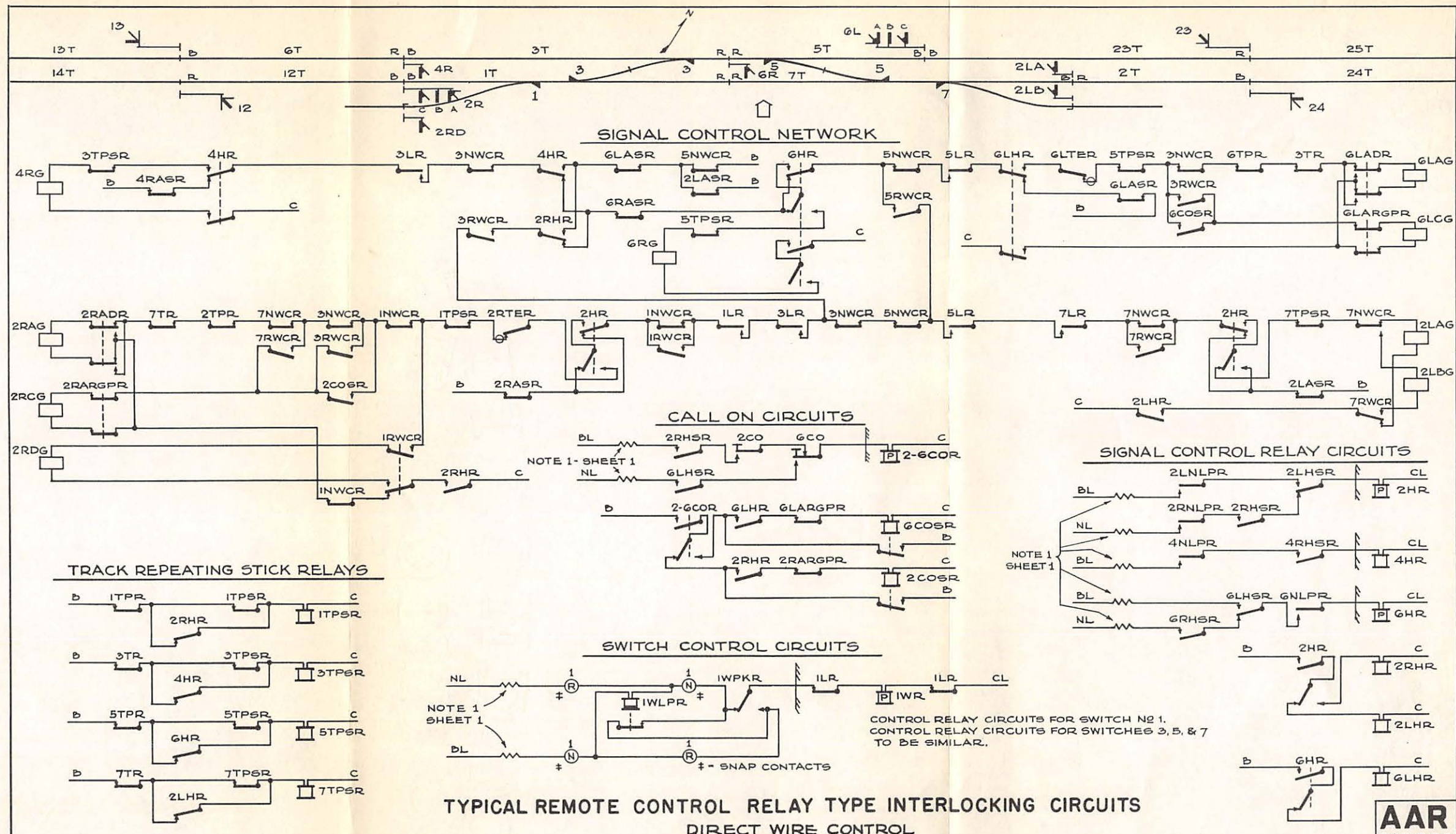
- NOTE 1. ARRANGEMENT OF LIGHTNING ARRESTERS CUTOUTS AND GROUNDING PROTECTION IS OPTIONAL.
2. 'ZR' IS USED AS A POLARITY CHECKING DEVICE TO PROTECT VITAL POLARIZED CIRCUITS FROM BEING ENERGIZED IN WRONG POLARITY IN EVENT OF OPEN BATTERY CIRCUIT.
3. WHEN 'ZR' RELAY IS BIASED NEUTRAL TYPE USE CONNECTION 'XY'.

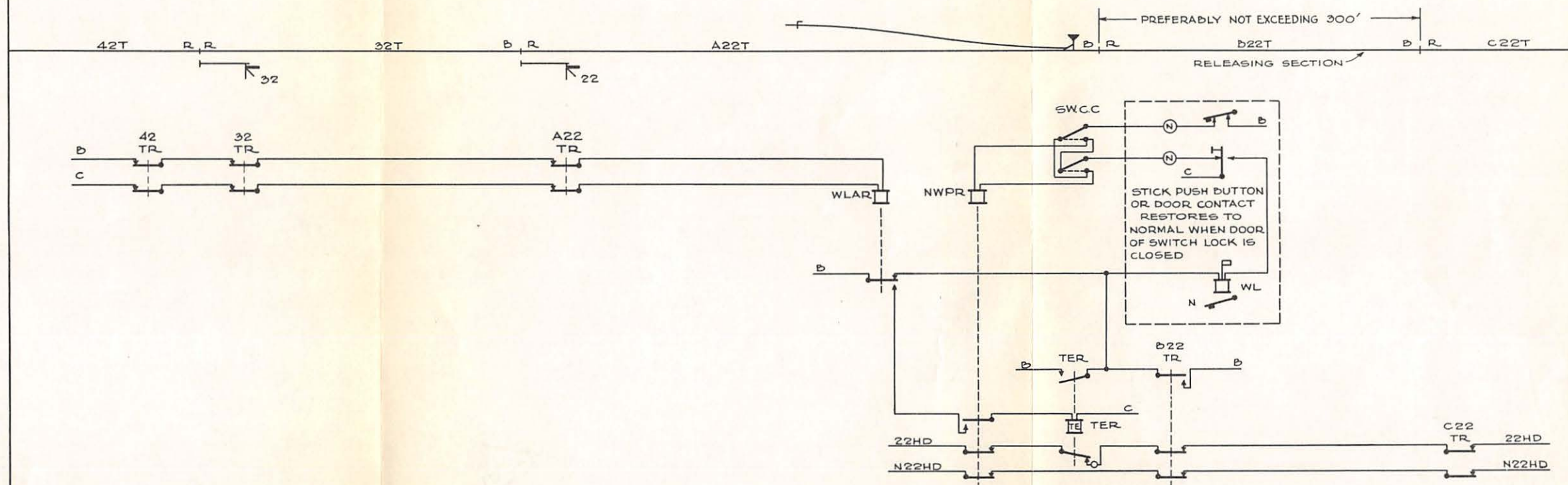
TYPICAL CIRCUITS FOR POWER DISTRIBUTION





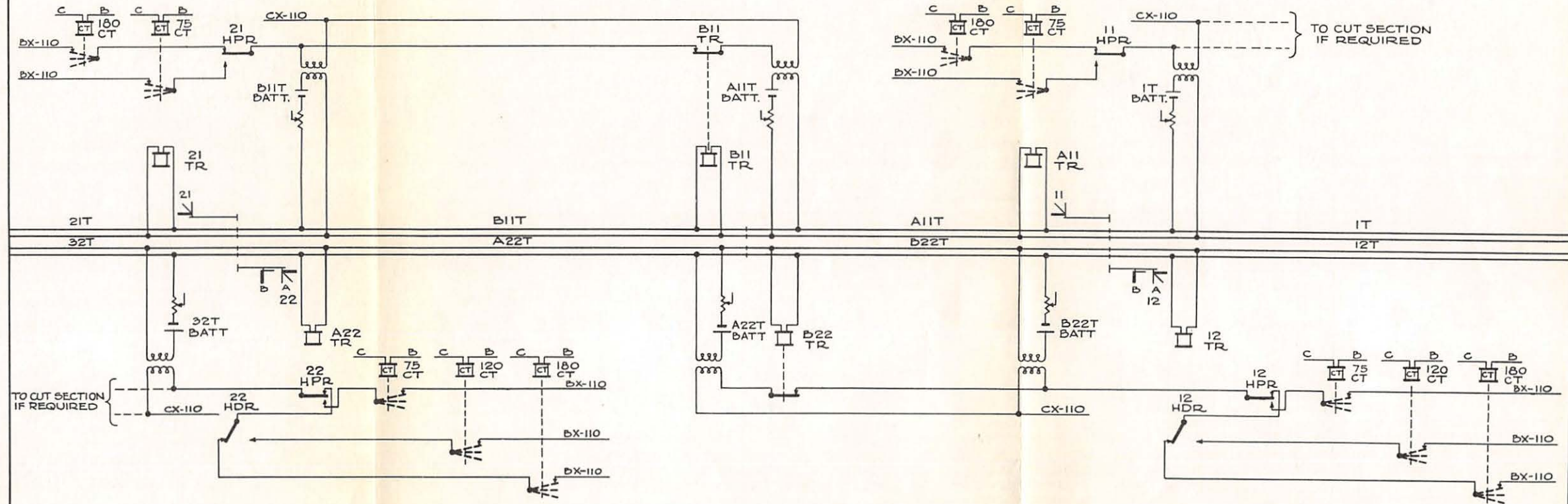






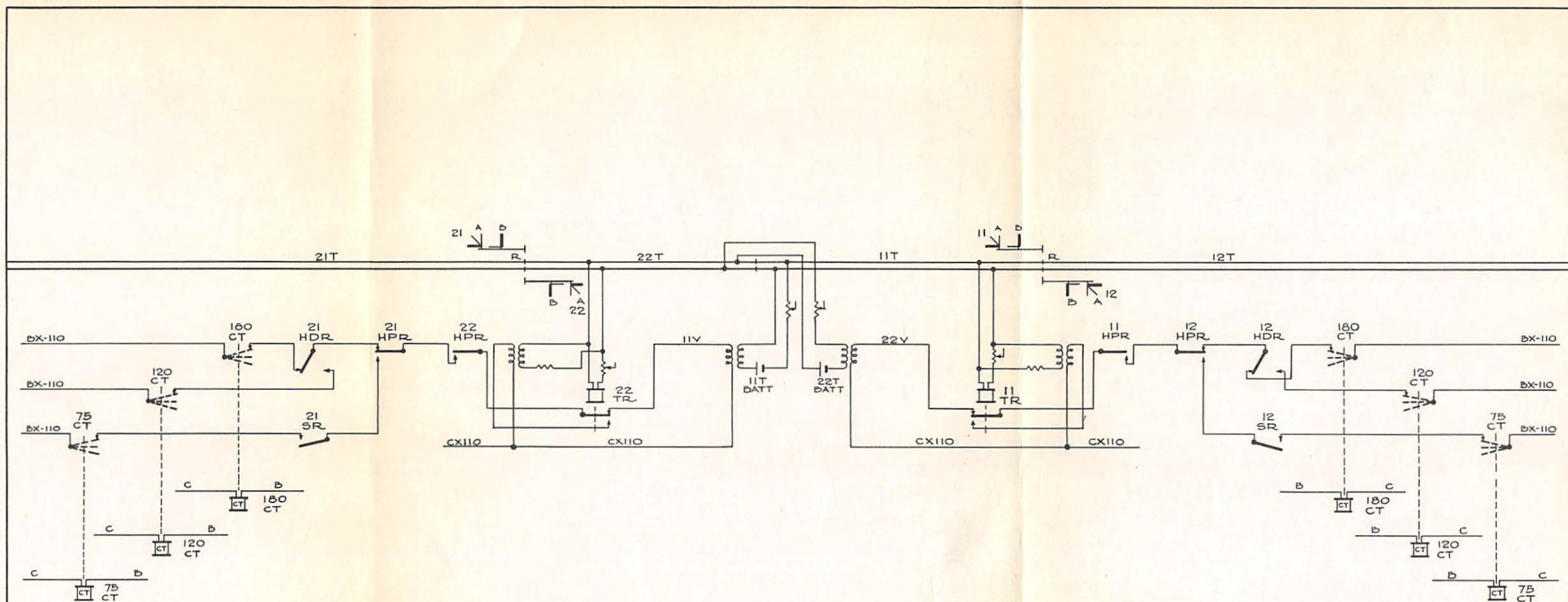
TYPICAL ELECTRIC SWITCH LOCK CIRCUITS
AUTOMATICALLY RELEASED, TIME AND APPROACH LOCKING
TRACK SIGNALLED IN ONE DIRECTION

**TYPICAL CIRCUITS TO SUPERIMPOSE CODED CAB SIGNAL CONTROLS
ON D.C. TRACK CIRCUITS**
TRACK SIGNALLED IN ONE DIRECTION
(CODE RULES 281-285-291)



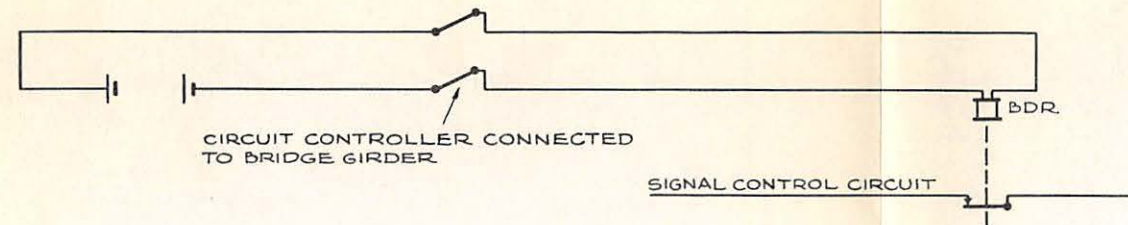
NOTE 1. CIRCUITS SHOWN ARE IN ADDITION TO THOSE REQUIRED FOR WAYSIDE SIGNALING SIMILAR TO PLAN NO 8002A.
2. RADIO INTERFERENCE AND ARC SUPPRESSION DETAILS NOT SHOWN.

**TYPICAL CIRCUITS TO SUPERIMPOSE CODED CAB SIGNAL CONTROLS
ON D.C. TRACK CIRCUITS**
TRACK SIGNALLED IN ONE DIRECTION
(CODE RULES 281-282-285-291)

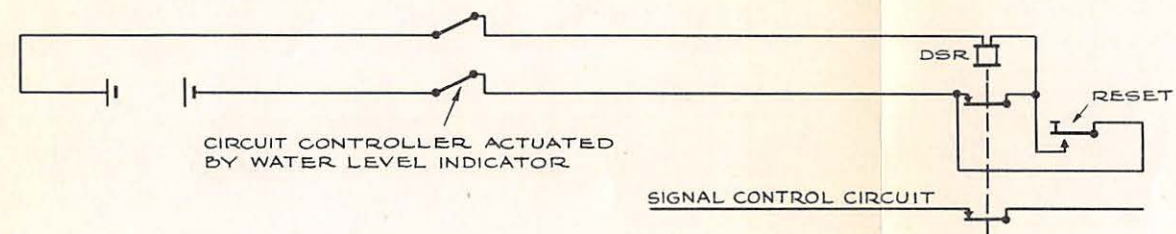


NOTE 1. CIRCUITS SHOWN ARE IN ADDITION TO THOSE REQUIRED FOR WAYSIDE SIGNALING SIMILAR TO PLAN NO. 8029A.
2. RADIO INTERFERENCE AND ARC SUPPRESSION DETAILS NOT SHOWN.

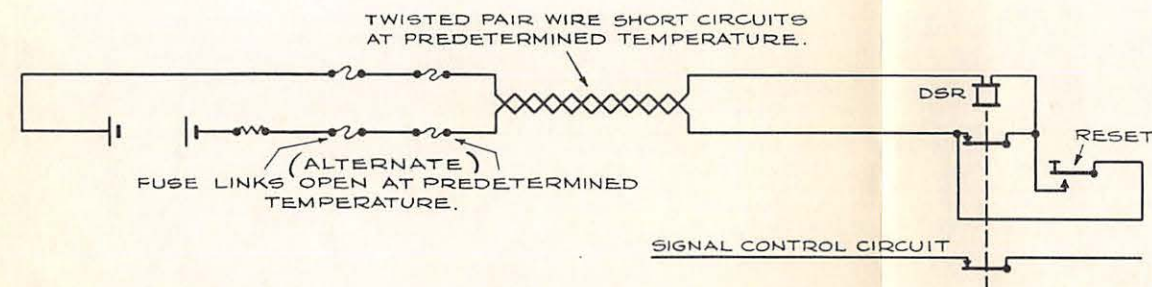
TYPICAL CIRCUITS TO SUPERIMPOSE CODED CAB SIGNAL CONTROLS
ON D.C. TRACK CIRCUITS
TRACK SIGNALLED IN BOTH DIRECTIONS
(CODE RULES 281-282-285-291)



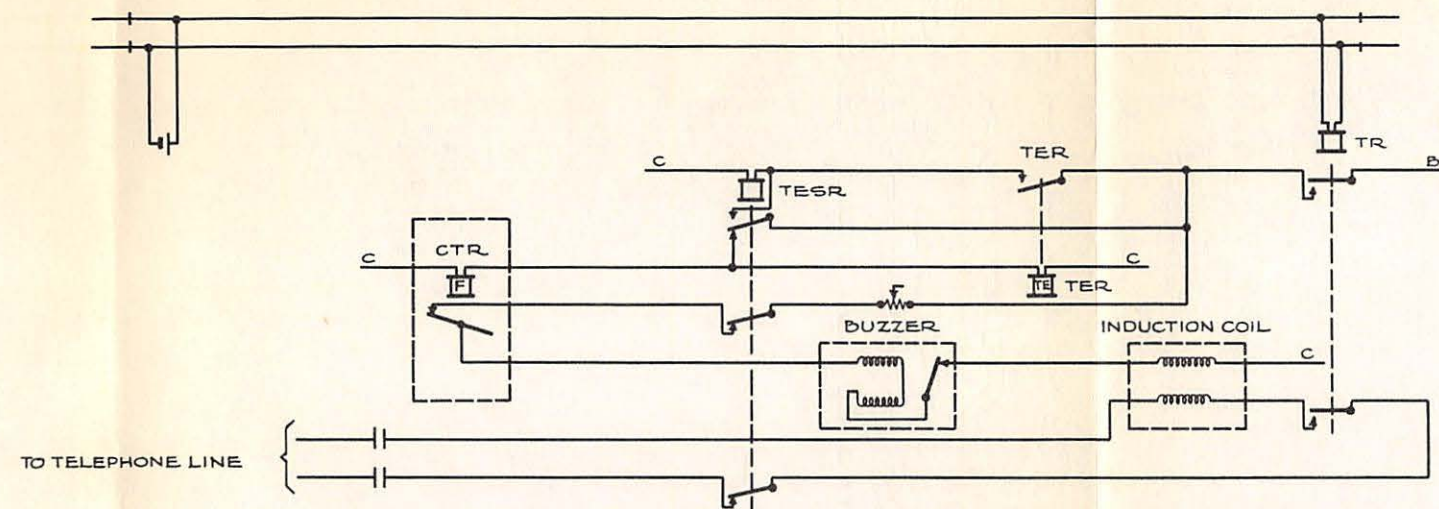
TYPICAL CIRCUITS FOR BRIDGE ALIGNMENT DETECTOR



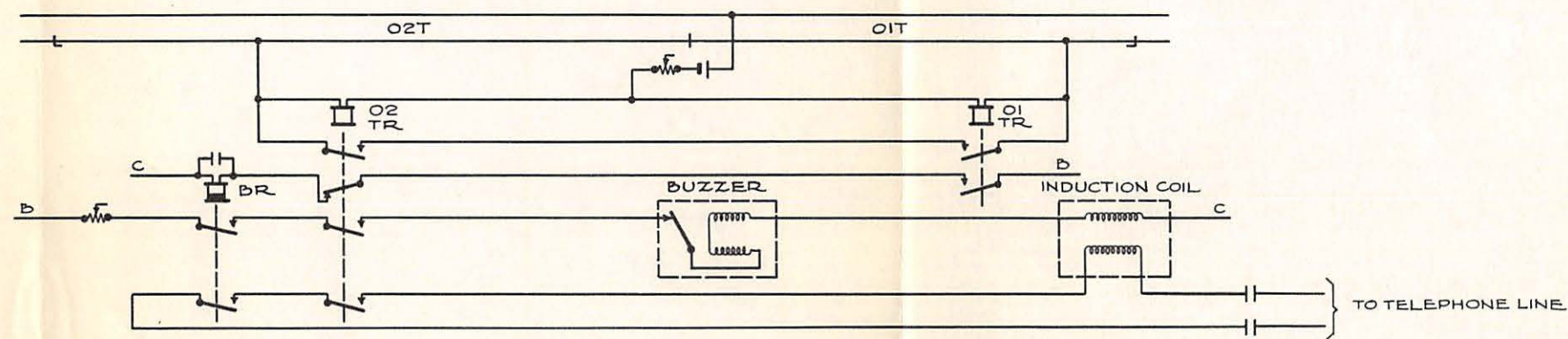
TYPICAL CIRCUITS FOR HIGH WATER DETECTOR



TYPICAL CIRCUITS FIRE DETECTOR



TYPICAL CIRCUITS FOR NON-DIRECTIONAL OS ing DEVICE
WITH TIME CUTOUT



TYPICAL CIRCUITS FOR DIRECTIONAL OS ing DEVICE.
FOR USE IN NON-SIGNAL TERRITORY

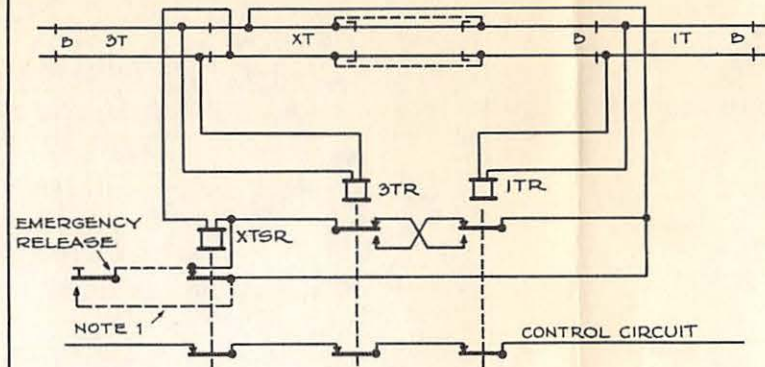


FIG. 1
USING THREE TRACK CIRCUITS
PICK UP OVER OUTER TRACK CIRCUITS

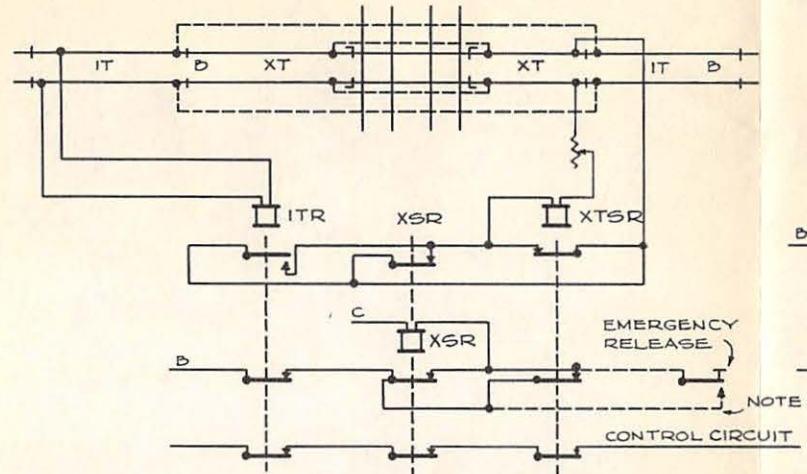


FIG. 2
SELF RESTORING IN EVENT XTSR
IS INDEPENDENTLY DE-ENERGIZED

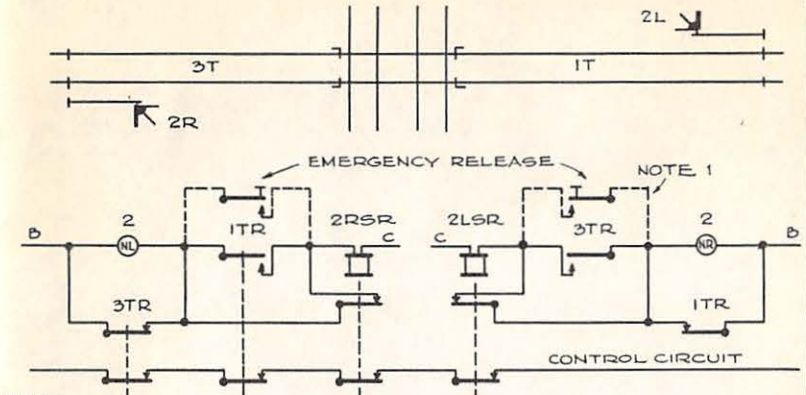


FIG. 3
FOR USE AT INTERLOCKINGS
PICK UP OVER RECEDING TRACK SECTIONS

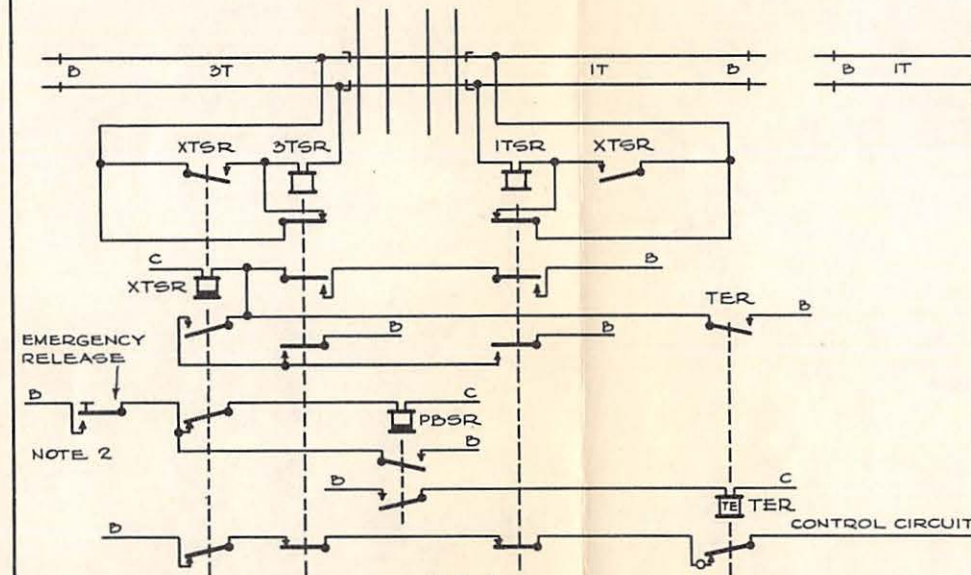


FIG. 4
PICK UP OVER RECEDING TRACK SECTION

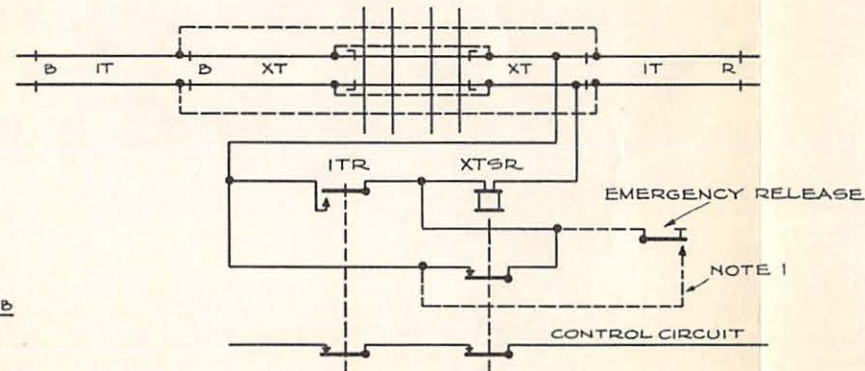


FIG. 5
USING TWO TRACK CIRCUITS
PICK UP OVER OUTER TRACK CIRCUIT

NOTE 1 EMERGENCY RELEASE SHOWN IN DOTTED LINE IS OPTIONAL. TIME DELAY IN FIG. 4 MAY BE INCLUDED IN EMERGENCY RELEASE CIRCUITS WHEN REQUIRED.
2. EMERGENCY RELEASE WITH OR WITHOUT TIME DELAY FEATURE IS OPTIONAL.

TYPICAL TRAP CIRCUITS

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SIGNAL SECTION A.A.R.

ADVANCE NOTICE

September 12, 13 and 14, 1949